Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXIV.—No. 3496] LONDON: FRIDAY EVENING, DECEMBER 29, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Highway Construction in China.

Aeroplane Exhibition in Paris.

A Study of Air-Steam Mixtures.

A Diesel-Electric Railway Coach.

Brown Coals and Lignites.

Electric Welding Equipment.

Recent Locomotive Design in New South Wales.

PUBLIC NOTICES

Assistant Locomotive SUPERINTENDENT REQUIRED for the NIGERIAN GOVERNMENT RAILWAY for two tours of from 12 to 16 months' service, with possible extension. Salary £480-£30-£720 a year. Outfit allowance of £60 on first appointment. Free quarters and first-class passages and liberal leave in England on full salary. Candidates, age 25 to 40, should be of good education and possess some approved engineering diploma. They should have served an apprenticeship in the locomotive workshops of one of the British railways in fitting, turning, erecting, pattern shop, foundry and drawing-office, and have had experience on the footplate. The candidate selected may be required to act as Assistant Works Manager, and applicants must therefore possess the necessary workshop experience to be able to undertake the duties of that post.
Apply at once by letter, stating age and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/11,745. 1057

Borough of Kingston-upon-Thames.
TECHNICAL INSTITUTE.
WANTED IMMEDIATELY, for Thursday evenings, an INSTRUCTOR in ELECTRICAL INSTALLATION and WIRING.
Salary at the rate of 10s. per hour for the first two hours, and at the rate of 8s. per hour for any period exceeding two hours, together with travelling expenses.
Applications, stating age, present occupation, qualifications, teaching and trade experience, and accompanied by copies of testimonials, to be forwarded to the Technical Institute, Kingston Hall-road, Kingston-upon-Thames.
H. T. ROBERTS, B.A.,
1066 Education Secretary.

Dorset County Council.
EDUCATION COMMITTEE.
WEYMOUTH ENGINEERING AND TECHNICAL SCHOOL.
A TEACHER of ENGINEERING SUBJECTS and MATHEMATICS is REQUIRED, to commence duties on 1st February, 1923, if possible. Candidates should be graduates or hold equivalent qualifications, and preference will be given to a candidate with experience in Motor Engineering. Salary according to the Burnham Scale for Teachers in Technical Schools.
Forms of application, which must be returned completed not later than the 6th January, 1923, may be obtained from the DIRECTOR of EDUCATION, County Education Office, Dorchester. 1080

Bengal-Nagpur Railway Company, Limited.
The Directors are prepared to receive TENDERS for :—
TOURING SALOON UNDERFRAMES (WITHOUT WHEELS AND AXLES).
Specification and form of Tender can be obtained at the Company's Offices, 132, Sheasham House, Old Broad-street, London, E.C. 2, on or after 22nd December, 1922.
A fee of £1 1s. will be charged for the specification, which will not be returned.
Tenders must be submitted not later than Noon on Wednesday, 10th January, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
E. C. VOLKERS,
1060 Secretary.

Romford Rural District Council.
RIVERSIDE SEWERAGE—WENNINGTON SECTION.
The Council invite TENDERS for the CONSTRUCTION of about 630 YARDS of 14in. and 420 YARDS of 12in. diameter PIPE SEWER with Manholes, &c., in the Parish of Wennington, Essex.
Drawings, specification, and quantities can be seen at the office of Mr. W. J. Grant, Surveyor to the Council, 16a, South-street, Romford; also at the office of Mr. William Fairley, Consulting Engineer, Parliament Mansions, Victoria-street, Westminster, S.W.
Tenders must be delivered to the undersigned on or before Monday, January 15th, 1923.
The Council do not bind themselves to accept the lowest or any Tender.
T. W. A. GREENHALGH,
Clerk to the Council.
16a, South-street,
Romford,
January 1st, 1923. P6618

Metropolitan Water Board.
MAIN—WESTMINSTER BRIDGE-ROAD TO VINE-STREET.
The Metropolitan Water Board invite TENDERS for the CONSTRUCTION of about 140 LINEAL YARDS of 24in. diameter MAIN and about 3070 LINEAL YARDS of 36in. diameter MAIN from the junction of Lower Marsh and Westminster Bridge-road, Lambeth, to Vine-street, Bermondsey, in the County of London.
Drawings, conditions of contract, and specification may be inspected without payment of fee at the offices of the Board, Chief Engineer's Department (Room 201), on and after Monday, 8th January, 1923.
Copies of drawings may be obtained at the cost of the tenderer through the Board's Photo Printers. Forms of Tender, conditions of contract, specification, and bills of quantities, together with a spare copy of the bills of quantities, may be obtained on and after 8th January, 1923, from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of £50, which sum must be deposited with the Accountant to the Board, and will be returned on receipt of a bona fide Tender accompanied by the above-named documents (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer), together with all copies of drawings obtained by the tenderer.
Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturday, 10 a.m. and 12 Noon). Cheques should be made payable to the Metropolitan Water Board and not to individuals.
Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, London, E.C. 1," and endorsed "Tender for Pipe Laying, Westminster Bridge-road to Vine-street," must be delivered at the offices of the Board not later than 10 a.m. on Wednesday, 24th January, 1923.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER,
Acting Clerk of the Board.
Offices of the Board,
New River Head,
173, Rosebery-avenue, E.C. 1,
23rd December, 1922. 1081

PUBLIC NOTICES

Town Council of Galston.
WATERWORKS EXTENSION.
CAST IRON PIPES.
The above-named Council invite OFFERS from responsible Ironfounders for the SUPPLY and FREE DELIVERY at Newmilns or Darvel, Ayrshire, of CAST IRON PIPES and SPECIAL CASTINGS in connection with the Waterworks Extension.
The Contract will comprise about 595 Tons of 9in. Pipes and 15 Tons of Special Castings.
Specification, bills of quantities, and form of Offer can be obtained from the Engineers, Messrs. Elliott and Brown, Burton Buildings, Parliament-street, Nottingham, on deposit of Two Guineas (by cheque), which sum will be returned on receipt of a bona fide Offer, not afterwards withdrawn, and return of quantities.
Sealed Offers, endorsed "Offer for Iron Pipes," to be delivered to the undersigned not later than the first post on Wednesday, the 3rd day of January, 1923.
By Order,
JAMES GUTHRIE,
Town Clerk.
Council Chambers,
Galston, Ayrshire. 1041

State Electricity Commission of Victoria.
TENDERS FOR PLANT.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification may be obtained or inspected upon application to—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION No. 23/6.—ASH and DUST EXTRACTION PLANT.
CHARGE.—£2 2s. for the first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A third or any further copies will be supplied for the sum of £1 1s. each, not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is required to be lodged with Tender.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m. on March 7th, 1923.
R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
993 Melbourne, Australia.

State Electricity Commission of Victoria.
TENDERS FOR PLANT.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for Morwell Power Scheme.
Copies of Tender form and specification may be obtained or inspected upon application to—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION NO. 23/8—TRANSFORMERS.
Charge 5s. for first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender.
A third or any further copies may be obtained on payment of 2s. 6d. per copy, not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of 1 per cent. of total Tender price is required to be lodged with Tender.
The Commission does not bind itself to accept the lowest Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Twelve Noon on the 31st March, 1923.
R. LIDDELOW,
1086 Secretary.

PUBLIC NOTICES

The Royal Borough of Kensington.
STEEL AND IRONWORK AND ROOFING MATERIAL.
The Council of the Royal Borough of Kensington are prepared to receive TENDERS for the PROVISION and ERECTION of the necessary STEEL and IRONWORK in connection with a Shed for the storage of vans, &c., to be provided by them at their Depot in Warwick-road, Kensington; also for the PROVISION and FIXING of ROOFING MATERIAL required in connection with the said shed.
Drawings and specifications can be inspected and all other particulars obtained from the Borough Engineer's Department at the Town Hall, Kensington, W. 8.
Tenders, endorsed "Tender for Steel, &c., Work" and "Tender for Roofing of Shed" respectively, must be delivered at the office of the undersigned not later than Twelve o' lock Noon on Monday, the 8th January, 1923.
Parties tendering will be required to make a declaration that they pay the rates of wages and observe the hours of labour recognised by associations of employers and trade unions and in practice obtained in the district in which the work is to be executed, and penalties will be enforced for any breach of such declaration on the part of the contractor.
The Council do not bind themselves to accept the lowest or any Tender.
The contractor will have to enter into a written contract and, if required by the Council, to provide two good and substantial sureties for the due performance thereof.
The contract deed will be prepared by and at the expense of the Council.
By Order,
WM. CHAMBERS LEETE,
Town Clerk.
Town Hall,
Kensington, W. 8,
20th December, 1922. 1058

The South Indian Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY of :—
1. STEEL TYRES for CARRIAGES and WAGONS.
2. ROLLED STEEL DISC WHEELS and AXLES for CARRIAGES and WAGONS.
3. SHEET and PLATE GLASS, &c.
4. SHEFFIELD TOOLS, &c.
5. LOCKS, &c.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Steel Tyres for Carriages and Wagons," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 19th January, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 5s. for each copy of each specification.
Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France, S.W. 1,
28th December 1922. 1070

SITUATIONS OPEN

WANTED, an ENGINEER with Theoretical and practical knowledge in designing Engines of the Central Exhaust and Extraction Types.
State age, previous experience, and salary required.
Address, P6616, The Engineer Office. P6616 A

PUBLIC NOTICES

ENGINEERING ASSISTANT.
Required in the Water Engineer's OFFICE, TORQUAY, an ENGINEERING ASSISTANT. Salary £300 per annum.
Applicants to be good draughtsmen, experienced in the preparation of plans and estimates, and must have had experience in Waterworks Construction. Candidates must hold the certificate of Assoc. M. Inst. C.E. or qualifying university degree.
Applications must be made upon the form of application provided, which can be obtained from the Town Clerk, Town Hall, Torquay.
Canvassing, either directly or indirectly, will disqualify.
Applications, addressed to the Town Clerk, must be received on or before Thursday, January 11th, 1923.
SAMUEL C. CHAPMAN, M. Inst. C.E.,
Water Engineer.
Town Hall, Torquay. 1052

SITUATIONS OPEN (continued)

WANTED, Good Keen MEN with Shop Experience for Writing Out Material Specifications; good opportunities for right type of man; must be accurate and quick.—Address, stating age, experience and salary required, 991, The Engineer Office.
991 A

ENGINEER WANTED for London Office. Estimating and purchasing. Good technical and commercial knowledge. Salary commencing £550 per annum.—Address, 1030, The Engineer Office. 1030 A

A LARGE FIRM in the North of England, Who Have in hand a large amount of constructional and mechanical work, REQUIRE several additional DRAUGHTSMEN as a temporary measure. Applicants should have considerable experience and be capable of carrying through work upon their own responsibility. Junior draughtsmen are not required.—Age, full particulars of experience and salary required should be stated, and applications should be made in the first instance to 1075, The Engineer Office.
1075 A

COMPETENT CONSTRUCTIONAL STEEL WORK DESIGNER REQUIRED for Architect's Office. State age, experience, and salary required.—Address, 1079, The Engineer Office. 1079 A

COMMERCIAL ENGINEER REQD., London. Thorough knowledge Crude Oil Firing and essentially a live wire in business methods. Age 28/30. £400/450 p.a.—Apply, LAURIE and CO., Employment Specialists, 28, Basinghall-street, E.C. No preliminary fee. P6622 A

ENGINEER, Plant Maintenance and Development.—The VACANCY advertised on October 27th has now been FILLED.—HANS RENOLD, Ltd., Didsbury, Manchester. 1055 A

LOCO. AND WAGON SHOP SUPERINTENDENT. —WANTED, for Railway in Central America, a MAN experienced in Erection and Maintenance of Locomotives, Carriages and Wagons. Knowledge of Spanish essential.—Write full particulars of past experience and salary expected, to "C. D.," c/o Street's 30, Cornhill, E.C. 3. 905 A

PATENT AGENT REQUIRES Qualified Experienced ASSISTANT and MANAGER, to commence February 1st. State age, salary expected, and past experience; satisfactory credentials essential.—Address, P6621, The Engineer Office. P6621 A

WANTED by Leading Firm, SENIOR DRAUGHTSMEN, with first-class experience for Lay-out and Detail Work on Switchgear; none but first-class men need apply.—Address, stating age, experience and salary required, 990, The Engineer Office. 990 A

WANTED, DRAUGHTSMAN, Accustomed to Design of High-speed Steam Engines and Centrifugal Pumping Machinery; London district. State experience and salary.—Address, 1062, The Engineer Office. 1062 A

WANTED, SEVERAL SENIOR SWITCHBOARD DRAUGHTSMEN.—Apply, stating age, experience and salary required, to BRITISH THOMSON-HOUSTON CO., Ltd., Drawing-office, Willesden N.W. 10. 1021 A

DRAUGHTSMEN, Accustomed to Traction Control Gear, WANTED.—Address, stating age, experience, and salary required, 1035, The Engineer Office. 1035 A

DRAUGHTSMAN, Between 25 and 35, Specialised in Cranes and Hydraulic Machinery. Application, by letter only, stating experience, references, and wages.—LEEDS ENGINEERING and HYDRAULIC CO., Ltd., Rodley, near Leeds. 1036 A

DRAUGHTSMAN WANTED by Important Firm in the Midlands manufacturing Steam Engines and Pumping Machinery. Applicant must have had shop training and wide experience.—Address, full particulars, stating age and salary, 1008, The Engineer Office. 1008 A

SITUATIONS OPEN (continued Page 2.

SITUATIONS WANTED, Page 2.

PARTNERSHIPS, Page 2.

PATENTS, Page 2.

MACHINERY, &c., WANTED, Page 92.

FOR SALE, Page 2.

AUCTIONS, Page 92.

PREMISES TO LET OR WANTED Page 2.

WORK WANTED, Page 2.

MISCELLANEOUS, Page 2.

For Advertisement Rates See Page 693, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS Page 91.

SITUATIONS OPEN (continued)

MACHINE TOOL DESIGNER WANTED for Special Tools. Applications are only invited from men of first-class ability. Reply, giving qualifications,—Address, "DESIGNER," Wm. Porteous and Co., Advertising Agents, Glasgow. P6575 A

MECHANICAL DRAUGHTSMEN REQUIRED for the Design of Mechanisms. Only good men with Shop Experience need apply. State age, salary and experience.—Address, 972, The Engineer Office. 972 A

REQUIRED IMMEDIATELY in London, Experienced DESIGNER of Enclosed Forced Lubrication Steam Engines. Pre-war experience. State full particulars, age and salary.—Address, 1063, The Engineer Office. 1063 A

SENIOR Mechanical Engineering DRAUGHTSMAN REQUIRED, preferably with knowledge of Centrifugal Pump Design and Details. State age, wage, and experience.—Address, 1082, The Engineer Office. 1082 A

TRANSFORMER DRAUGHTSMAN. — APPLICATIONS are REQUESTED for the APPOINTMENT of TRANSFORMER DRAUGHTSMAN with well-known British Firm of Electrical Engineers.

Applicants must have had first-class experience in the design and manufacture of Large High-tension Transformers.

The position would be a permanency and offers ample scope to a suitable man. Applications will be treated with strict confidence.—Address, 1059, The Engineer Office, giving full particulars of experience. 1059 A

WANTED, FOREMAN ERECTOR for Live Rear Axles for Motor Vehicles, with experience of testing.—Address full particulars of experience, 1069, The Engineer Office. 1069 A

SITUATIONS WANTED

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 1084 B

DIESEL ENGINE DESIGNER, with Charge of Oil Engine department abroad, WISHES SIMILAR POSITION in this country.—Address, P6609, The Engineer Office. P6609 B

ENGINEER, Young, Single, French Engineering graduate, fluent English, French, German, Polish and Russian, many years' practical experience with leading English firms, DESIRES APPOINTMENT.—"ENGINEER," 2, Franconia-road, S.W. 4. P6623 B

MECHANICAL ENGINEER (36), B.Sc., A.M.I.C.E., trained marine shops and drawing-office, experience in design, construction and operation steam power plants, internal combustion engines and steel constructional work, both at home and abroad, DESIRES POSITION of RESPONSIBILITY. Commercial, correspondence and sales experience; capable technical linguist; educated public school.—Address, P6614, The Engineer Office. P6614 B

DRAUGHTSMAN, Assistant (18), DESIRES SIT. Experience in making working drawings, finished drawings (on linen cloth) blue prints, measuring up and estimating; excel. refs.; salary second consideration.—S. F., 124, Acomb-street, M.S., Manchester. P6617 B

DRAUGHTSMAN SEEKS POST; Cable Machinery, naval ordnance machinery, refrigerating machinery, cranes and hydraulic pumps, research work. Excellent references.—RUSSELL, 436, High-st., Lewisham, S.E.13. P6615 B

DRAUGHTSMAN-DESIGNER (30). Thoroughly capable man, 5 years shops, 18 years' extensive D.O. experience, covering wide range mechanical engineering, inventive, capable designing original machinery throughout, expert at patent applications, has held positions for many years as section leader, leading draughtsman, checker, &c., with large firms, receiving £6 to £7 per week (and over), OFFERS SERVICES for £4 10s. per week to secure employment, temporary or otherwise.

Address, P6612, The Engineer Office. P6612 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.,
46, Watling Street, London, E.C. 4.

Established seventy years.

EDUCATIONAL

A BROCHURE on "ENGINEERING SALESMANSHIP and SALES MANAGEMENT," with particulars of a SPECIAL COURSE of TRAINING, will be sent post free on application to SECRETARY, THE INSTITUTE OF ENGINEERING SALESMANSHIP, 339, Oxford-road, Manchester. P6195

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. Matric., Inter. and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours); Assoc. M. Inst. C.E., M.E.S.I., F.R.S.A. &c. Also Day Tuition in Office. Excellent results at all Exams. Course may commence at any time.—9/11, Bradford Chambers, 59 South John-street, LIVERPOOL. Ex. B

INST. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS. — Mr. G. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E. &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Courses can be commenced at any time.—39, Victoria-street, Westminster S.W. Telephone No., Victoria 4780. Ex. B

LEARN SURVEYING AND LEVELLING.—Thorough practical instruction given by an expert.—Address, E. MOUL (late L.S.W. and S.P.D. Rlys.) Hollybank, Woking. P6221 B

PATENTS

INVENTIONS DEVELOPED, PATENTED, and SOLD for Clients by Engineers (late of Vickers Ltd., B.Sc., M.E. Ae. S., A.M.I. Ae. E.). Strictest confidence, most moderate terms.—FORTIS and PARTNERS, 60, Queen Victoria-street, E.C. 4. Tel., Cent. 3864. 512 B

THE PROPRIETORS of PATENT No. 100,686, "DIMINISHING RECOIL of GUNS," are DESIROUS of ENTERING into ARRANGEMENTS by way of LICENSE and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to J. E. EVANS-JACKSON and CO., Patent Agents, 57/60, Holborn-viaduct, Lond n, E.C. 1. P6576 B

MISCELLANEOUS

ELTON, LEVY and CO., Ltd., Metal Merchants, Granville Park Works, Edmonton, London, are CASH BUYERS of all classes of OLD ELECTRICAL, BREWERY and CHEMICAL PLANT, Switchboards, Transformers, Batteries, Switchgear, Locomotive and Aeroplane Parts, Cable. No parcel too small or too large. Send particulars of material in this country or abroad. Distance no object. Expert at your disposal and good cash offer. 1078 I

MACHINE TOOL MAKERS, with Well-introduced Specialities in Horizontal, Radial and Vertical Drilling and Boring Machines, are OPEN to DISPOSE of DRAWINGS, JIGS, DESIGNS, and MANUFACTURING RIGHTS. Great development possible to enterprising practical men.—Address, 1023, The Engineer Office. 1023 I

IF YOU REQUIRE
DIVIDING HEADS for MILLING.
ROTARY TABLES for
SLOTTING and MILLING,
Write to
THE WHEELER MNFG. CO. Ltd.,
65F, Trench Crossing, Wellington, Salop.

FOR SALE

FOR IMMEDIATE DISPOSAL, the Following WOODHOUSE "CLUTCH" PULLEYS fitted with Roller Bearings:—

No.	H.P.	R.P.M.	Diam.	Face.	Bore.
6	44	720	12in.	12in.	2¾in.
6	32	720	12in.	9in.	2¾in.
1	25	720	12in.	9in.	2¾in.
4	35	485	12in.	12in.	2¾in.

No reasonable offer refused.—For particulars to view address 1064, The Engineer Office. 1064 G

FOR SALE, LANCASHIRE BOILER and MOUNTINGS, steaming at 120 lb. per sq. inch; very good insurance report.—For particulars apply to H. V. NORTON, Waterworks Engineer and Manager, Chopping Wycombe Waterworks, 71, Easton-street, High Wycombe. 1054 G

FOR SALE, PORTABLE STEEL-FRAMED GALVANISED CORRUGATED IRON BUILDING, 80ft. by 40ft., 11ft. eaves, suitable workshops, garage, or fireproof stores; standing near London. To be sold a bargain.—Mr. BRYCE, 12, Ormiston-rd., W. 12. P6619 G

FOR SALE, the Largest Stock in the Country of Unused WROUGHT IRON SCREWED and SOCKETTED PIPES, both brand new and ex-Army stocks, as follows:—

11,000 feet, 9" Steam.
100,000 feet, 8" Water.
185,000 feet, 4" Water.
47,000 feet, 5" Water.
12,000 feet, 3" Steam.
40,000 feet, 2" Water.
80,000 feet, 1½" Water.
Also 1", 1", ¾", 3/8".
100,000 feet of 4" Solid-drawn Steel with loose flanges.
4500 feet, 8" Weldless Steel S. and F.
6000 feet, 6" Ditto.
GEORGE COHEN, SONS and CO., 600, Commercial-road, London, E. 14. 386 G

FOR SALE, the Whole MACHINERY Used for WINDMILL: 40 H.P. National GAS ENGINE with Producer, with 63ft. 6in. Belting; Turner's No. 16 CORN MILL, Shafting, Bearings, &c. What offers?—HOLCOMBE, Builder, Crowborough. P6619 G

FOR SALE, THEODOLITES, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road).

FOR SALE, LEVELS, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn W.C. (Opposite Gray's Inn-road). Ex. G

FOR SALE, 5-Ton "Foden" END TIPPING WAGON, rubber tyres, good condition; £265. Also 4-Ton END TIPPING TRAILER, steel wheels, rubber tyres; £85.—Address, P6620, The Engineer Office. P6620 G

FOR SALE.

16in. SIX WHEELS COUPLED LOCO., built 1918, 160 lb. pressure.

12in. SIX WHEELS COUPLED LOCO., rebuilt this year, 160 lb. pressure.

5-TON WILSON CRANE, with shunting carriage.

TWO NEW HONE GRABS, 1 cub. yd. capacity.

FRANK EDMUNDS,
BARLASTON, STOKE-ON-TRENT. Ex.

FOR SALE—
ONE PUMPING SET, comprising two-cylinder "Aster" Engine, coupled direct to a 6in. Fulscometer Centrifugal Pump; capacity 700 galls. per minute to 80ft. head.
ONE 50 K.W. Belt-driven DYNAMO, by Newtons, 440/460 volts D.C., 780 r.p.m., complete with Switchboard.
ONE 20 K.W. Belt-driven DYNAMO, by Siemens Bros., 220/320 volts, 900 r.p.m. D.C.
ONE 35 K.W. ELECTRIC GENERATOR, by the Phœnix Dynamo Mfg. Co., Bradford, 230 volts D.C., 152 amps. 850 r.p.m.
ONE 35 K.W. ELECTRIC GENERATOR, by the Brush Electrical Co., Loughborough, 230 volts D.C., 153 amps., 1100 r.p.m., complete with Slide Rails and Pulley.
1414ft. run of NEW 15in. CAST IRON DOUBLE-FLANGED PIPE, flanges faced and drilled to B.S.T. No. 2.
ONE NEW 12½in. centre LATHE, 10ft. 6in. gap bed, S.A., S.S., and S.C., by Robson; complete with countershaft.
ONE 36in. VERTICAL DRILLING MACHINE, to drill 12in., automatic and hand feeds, back-geared.
ONE Belt-driven NIBBLING MACHINE, by Burton, Griffiths; admits 30in. in mouth, overhead motion.
ONE Belt-driven EMERY FACE GRINDER, by Burton, Griffiths.
ONE Churchill 18in. DOUBLE-DISC GRINDER.
TWO No. 5 and ONE No. 31 ARBOR PRESSES.
STANLEY ENGINEERING CO., Bath. Ex. G

FOR SALE

FOR SALE.—
4in. SUBMERSIBLE PUMP, output 100 tons per hour at 75ft. total head, 160 tons per hour at free discharge, driven by 15 H.P. electric motor, 220 volts, 3-phase, 50 periods, 1420 r.p.m., complete with rotary transformer, primary 22 H.P., 100 volts, 172 amps., secondary 17 K.V.A., 220 volts, 44 amps., enclosed type, starter, connecting cable, suction hose, spares and trolley. Makers, Submersible Motors, Ltd.
Particulars from MURRAY, McVINNIE and CO., Ltd., Mavisbank, Glasgow. 1067 G

FORTY MILD STEEL STORAGE TANKS, 30ft. by 6ft., 11-16 plates; could also be used as air receivers; equal to new.—WILLIAM KAYLEY, Queen-street Ironworks, Chancery-lane, Ardwick, Manchester. Telegrams, 8397 City, 1058 Central. 1072 G

FOUR SETS of 1100 I.H.P. NEW VERTICAL TRIPLE-EXPANSION MARINE ENGINES, by Cooper and Grieg, Dundee; diam. of cyl. 13½, 21½, stroke 21. Including Boilers, 220 lb. pressure.
ONE SET of 1400 I.H.P., 4-Cyl. TRIPLE-EXPANSION MARINE ENGINES, by Dunsmuir and Jackson, Ltd., Glasgow; built in 1918 only; diam. of cyl. 21 7-8, 35 11-16, and 58½, stroke 27; Boiler, 180 lb. pressure, I.K. 136.
TWO SETS of 750 I.H.P. VERTICAL TRIPLE-EXPANSION MARINE ENGINES, by Vickers Ltd., Barrow; diam. of cyl. 11½, 18, and 28; suitable for 225 lb. pressure.
TEN SETS of 1400 I.H.P. Diagonal COMPOUND MARINE ENGINES, diam. of cyl. 26½ and 52, stroke 34; built in 1916; speed 55 revs.; with Boilers, suitable for 125 lb. pressure.
ONE SET of 2500 I.H.P. Nearly New 4-Cyl. TRIPLE-EXPANSION MARINE ENGINES, by Bardair, Carle and Co., Glasgow; diam. of cyl. 20½, 30, 37, and 37, stroke 30; including Boilers, pressure 180 lb.
All the above have propeller shafts, blades, and all auxiliary machinery.
Suitable for single or twin-screw boats.
Price on application.
THOS. W. WARD, Ltd., Sheffield.

GRIDLEY AUTOMATIC, Single-spindle, for 2¼in. bars, condition equal to new.—A. E. WARD and CO., Livery-street, Birmingham. 981 G

MACHINE TOOLS FOR SALE.

SET of PLATE BENDING ROLLS, 16ft. by 14in., by Craig and Donald.
SET of DITTO, 16ft. by 14in., by Berry.
16ft. PLATE EDGE PLANING MACHINE, by Smith, Glasgow. Practically new.
TWO 20in. centre by 30ft. bed SLIDING, SURFACING and SCREW-CUTTING LATHES, by Berry; all-geared head, swing 20ft. between centres.
TWO 5ft. Bickford RADIAL DRILLING and TAPPING MACHINES, gear-box drive.
ONE New 4ft. Alfred Herbert RADIAL DRILLING and TAPPING MACHINE, gear-box drive.
ONE Practically New Webster and Bennett 40in. DUPLEX TURNING and BORING MILL, gear-box drive.
ONE 5ft. Smith and Coventry Double-headed VERTICAL BORING and TURNING MILL for motor drive.
FOUR 100-Ton Taylor and Challen Geared POWER PRESSES, 18in. stroke, admit 42in. between side standards.
Tullis HORIZONTAL DRILLING MACHINE, 2½in. dial spindle, 48in. square compound revolving table; motor driven.
Horizontal Backh ard ANGLE PUNCH and DOUBLE ANGLE CROPPING MACHINE, to cut 8in. by 8in. angles.
Full particulars and prices, &c., from GEORGE COHEN SONS and CO., 600, Commercial-road, London, E. 14. Ex. G

ONE Double-ended PUNCHING, SHEARING, ANGLE and FLAT BAR CUTTING MACHINE, shear and punch gape 18in., with fast and loose pulleys, 24in. by 4½in.; fly-wheel, 4ft. by 24in. face; constructed to punch and shear 2in.; makers, De Bergue and Co., Manchester; equal to new.
ONE 36in. BAND SAWING MACHINE, table 3ft. 6in. square; maker, Robinson, Rochdale; equal to new.
ONE PIPE SCREWING MACHINE, to screw from 2in. to 6in., with 114 dies; maker, Joshua Heap and Co., Ltd.
ONE Alley and McLellan "VERTICAL COMPRESSOR, 300ft. capacity at 100 lb.
ONE "Alley and McLellan" HORIZONTAL COMPRESSOR, 300ft. capacity at 100 lb.
ONE "F. W. Brackett" HORIZONTAL COMPRESSOR, 300ft. capacity at 100 lb.; equal to new.
ONE RECEIVER.
ONE RECEIVER.
ONE RECEIVER.
WILLIAM KAYLEY, Queen-street Ironworks, Chancery-lane, Ardwick, Manchester. Telegrams, 8397 City, 1058 Central. 1074 G

PLANING MACHINES.—
SEVERAL Redman PLANING MACHINES:—

	Self-acting	Rack-driven
8ft. by 3ft. by 3ft.,		
6ft. by 3ft. by 3ft.,		
6ft. by 2ft. by 2ft.		

T-slotted tables, cheeks to floor, graduated toolboxes, &c.
THOMAS MITCHELL and SONS, Ltd., Bolton. Telephone, 302; Telegrams, "Realise." 975 G

PORTABLE RAILWAY MATERIAL, WAGONS, TRACK, CROSSINGS, TURNTABLES, &c.—PLEASE NOTE.—We are now in a position to SUPPLY NEW MATERIAL of superior make from stock at lowest prices.—JOSEPH PUGSLEY and SONS, Ltd., Cattybrook Ironworks, Lawrence-hill, Bristol. Telegrams, "Pistol, Bristol." Telephone No. 139. 288 G

PRESS, ONE NEW HYDRAULIC BALING, Capacity 200 tons; cost about £4500; offers invited.—The LIQUIDATOR, Scottish Mesopotamia Corporation, Ltd., 31, George-street, Edinburgh. 800 G

RAILWAY MATERIAL.—
NEW and SECOND-HAND CREOSOTED SLEEPERS and CROSSING TIMBERS from large stocks. All sections of NEW and SECOND-HAND STEEL RAILS with accessories.
R. H. NEAL and CO., Contractors' Engineers, 53 The Broadway, Ealing, London, W. 5. 806 G

SECOND-HAND MACHINERY FOR DISPOSAL, consisting of Electrical, Woodworking, Laundry, Printing and Tin Box Making Equipment; also Bollers, Locomotives, Engines, Presses, Crushers, &c. Being replaced by up-to-date machinery. Prices and schedule on application.—Address, 1056, The Engineer Office. 1056 G

FOR SALE

STEEL STRUCTURE, Equal to New, 250ft. by 64ft. by about 40ft. to eaves, match-lined, and building is bolted throughout.
TWO 30ft. by 8ft. LANCASHIRE BOILERS, by Adamson, for 120 w.p.
ONE 30ft. by 8ft. DITTO DITTO, by Danks, for 120 w.p.
ONE 30ft. by 8ft. DITTO DITTO, by Beeley, for 120 w.p. All mountings, &c.
A. MEIN, Station-street, Stratford, E. 15. 1076 G

THREE STEEL and CORRUGATED IRON BUILDINGS, 180ft. long by 40ft. wide, by 24ft. to the eaves, new.
THREE STEEL and CORRUGATED IRON BUILDINGS, 75ft. long by 57ft. wide, with Belfast roofs.
THREE STEEL and CORRUGATED BUILDINGS, 106ft. long by 32ft. wide by 24ft. to the eaves.
FIVE STEEL CHIMNEYS, 85ft. by 4ft. dia., with large cast iron base-plate, self-contained.
WILLIAM KAYLEY, Queen-street Ironworks, Chancery-lane, Ardwick, Manchester. Telegrams, 8397 City, 1058 Central. 1073 G

TWO 125 H.P. Bellis COMPOUND ENGINES (enclosed), 400 r.p.m., 140 lb. pressure. Also THREE 100 H.P. DITTO. These engines are in new condition. Prices £225 each and £100 each respectively.—HARRY H. GARDAM and CO., Limited, Engineers, Staines. 991 G

FOR SALE.
6-WHEEL COUPLED SADDLE-TANK LOCOMOTIVE (Manning-Wardle's), with inside cyls. 12in. diam. by 18in. stroke, copper fire-box, 140 lb. w.p.; sale or hire.
3-TON "GRAFTON" LOCO. STEAM CRANE, with 27ft. 6in. steel jib, 4ft. 8½in. gauge, all motions by steam, boiler for 70 lb. w.p.
2-TON "APPLEBY" LOCO. ELECTRIC CRANE, with 20ft. latticed jib, 4ft. 8½in. gauge, driven by three 220-volt D.C. motors.
5-TON HAND DERRICK CRANE, with 48ft. 6in. timber jib, two wire ropes.
"RANSOME" CONCRETE MIXER, 1 cubic yard capacity, feeding hopper, delivery chute, water tank, steel framework.
THREE "PETER'S" SINGLE-CHAIN GRABS, each about 1 cubic yard capacity, fitted with teeth.
10-TON "TOWER" TYPE STEAM NAVVY, with bucket 1¼ cubic yards capacity, gauges 4ft. 8½in. and 11ft., boiler for 160 lb. w.p.
CATALOGUE of STOCK MACHINERY, 8000 Lots, Free on application. Inspection invited.
THOS. W. WARD, Ltd., ALBION WORKS, SHEFFIELD.

264 K.W. STEAM GENERATING SET, by well-known maker, new 1917, 110 volts, compound engine, entirely self-contained. Price £175 f.o.r. Staines.—HARRY H. GARDAM and CO., Limited, Staines. 998 G

41 B.H.P. Ruston HORIZONTAL CRUDE OIL ENGINE, single 29-wheel type, modern, in new condition. Low price for immediate acceptance.—HARRY H. GARDAM and CO., Limited, Staines. 995 G

65 AIR RECEIVERS, Egg Ends, 18ft. 6in. long by 4ft. 6in. dia., 1-4in. plate, with flange, 600 lb. w.p., lying Stamford, Lincs.—MAIDEN and McKEE, Ltd., 317, Prescot-road, Liverpool. 1083 G

500 H.P. HORIZONTAL CROSS COMPOUND SURFACE CONDENSING STEAM ENGINE by Marshalls, Gainsborough; drop valves, in excellent condition.—HARRY H. GARDAM and CO., Limited, Staines. 868 G

700 H.P. HORIZONTAL STEAM ENGINE, by Hick Hargreaves, new 1911, Corliss valves, jet condensing.—HARRY H. GARDAM and CO., Limited, Staines. 867 G

WORK WANTED

WANTED to MANUFACTURE, SPECIAL MACHINERY or ENGINEERS' APPLIANCES. Up-to-date machine plant for either heavy or medium work. Own foundry and pattern shop.—EASTON and JOHNSON, Ltd., Engineers, Taunton. Ex. M

ENGINEERING WORKS, Old Established, are OPEN to MANUFACTURE ANY ARTICLE having good sale on mutual basis.—Address, 1018, The Engineer Office. 1018 M

IRON CASTINGS (up to 15 tons each)
In Loam, Dry and Greensand.
Machine Moulded Gear Wheels up to 12ft. dia.
Fly Rope Driving Pulleys, and Fly Spur Driving Wheels up to 28ft. diameter.
GEARING OF ALL DESCRIPTIONS.
Enquiries invited from Engineers and other users.
CLAYTON, GOODFELLOW & Co. Ltd.
Engineers & Ironfounders, Atlas Works, Blackburn.

IRON CASTINGS.
REPETITION WORK AND MACHINE MOULDING A SPECIALITY.
The Heatly-Gresham Engineering Co., Ltd.
LETCHWORTH, HERTS, or
63, WOOD STREET, WESTMINSTER, S.W. 1.
Ex.

MESSRS. J. H. GREEN & CO.
ENGINEERS AND SMITHS,
Cook Street Ironworks,
CHAPEL STREET, SALFORD.
IRON AND STEEL WORK
of all Descriptions made to your Specifications.
Specialists in Wrot Iron Ladders

Z. D. BERRY and SONS, Engineers, The Albion Works, Regency-street, Westminster, S.W. 1 (Established 1810), UNDERTAKE MACHINING and GENERAL WORK. Lathes up to 9in. centres with gap beds, Capstans, Automatics for bar work, Radial and Vertical Drills, Planing up to 9ft. by 4ft. by 4ft., Shaping, Milling, Gear Cutting to 36in. dia., Internal, External and Surface Grinding, Hand Forging, Small Press Work, &c. 594 M

WORK WANTED for Modern Plant. Could Undertake medium or small machinery, complete or component parts. Inquiries invited. We specialise in Jigs and Tools. Prompt deliveries, keen prices and best workmanship guaranteed.—GRIMSLEY and CO., Queen-street, Leicester. 1018 M

"SQUEEGEE" PUMPS
FOR ANY FLUID.
Avamore Pump Co. Ltd.,
Haslemere, SURREY.

Burckhardt Engineering Works.
COMPRESSORS & VACUUM PUMPS.
Machinery for Sheet Metal Working.
Delivery from Stock.
26, Victoria Street, Westminster, S.W. 1. Works—Basle, Switzerland.
See Illustrated Advertisement in issue of December 15th

The Wellman Smith Owen Engineering Corporation Ltd.
Kings House, Kingsway, London, W.C.2
CRANES · TRANSPORTERS
See Our Illustrated Advt. Next Week

Recent and Future Locomotive Design in New South Wales.

A VERY interesting paper under the title given above was read in September last by Mr. E. E. Lucy, M.I. Mech. E., Chief Mechanical Engineer of the New South Wales Government Railways, before the Sydney Division, Institution of Engineers, Australia. We give some extracts from it below.

The topography of New South Wales has necessitated on all main lines considerable curvature with heavy gradients, and frequent gradient changes, features which showed the advantages of the flexibility of American type engines as compared with the more rigid British designs. Several types of locomotives were designed locally, incorporating features of both American and British practice. These engines were fully compensated, fitted with plate frames and outside cylinders, but had the steam chests between the frames, as tests had shown that the coal consumption of saturated steam locomotives fitted with the American type of steam chests above outside cylinders was considerably greater than that of similar locomotives with steam chests between the frames. In the case of superheated locomotives the difference is not appreciable.

SUBURBAN ENGINES.

The "S" class engine is a 4–6–4 suburban tank engine with a spring-controlled bogie at the leading end, and a cradle suspension-link bogie at the trailing end, the bogie wheels being 3ft. 1in. diameter. The initial centering force for the hind bogie is 1.43 tons, increasing to 2.2 tons for 1in. displacement from the central position. The centering force of the leading bogie for 1in. displacement is 1.4 tons, the greater distance from the centre of gravity of the engine requiring less stiffness for the leading bogie. The bogies are of the plate-frame type, with laminated springs, the journals being 10in. by 5½in. The coupled wheels are 4ft. 7in. diameter, the journals being 10½in. by 7in. Wheel centres of cast steel with tires to British standard specification—class "D." The standard shrinkage allowance for tires, which is found entirely satisfactory, is .047in. for a tire diameter of 36in., increasing uniformly to .078in. for a diameter of 96in.

The cylinders are 18½in. by 24in. with inside steam chests fitted with snifting valves. Allan's straight link motion is used. The boiler is of the narrow firebox Belpaire type, worked at 160 lb. Superheaters are not used on this class of suburban tank engine. All side stays are of copper, 1in. diameter, drilled with $^{3}/_{16}$in. holes for a length of 1½in. from each end. They are headed by pneumatic rotary hammers. The crown stays are of mild steel, screwed through both copper and steel plates, and nutted on the outside. The standard practice in New South Wales is to fit a brass sleeve over all crown stays from the copper plate to a point clear of the water line, the space between the body of the stay and the sleeve being filled with Portland cement mortar. This device has practically eliminated crown stay wastage, whereas previously it was not uncommon to remove stays wasted to ¼in. diameter just above the copper plate. The tubes are of copper, 1¾in. outside diameter, expanded into the tube plate and ferruled at the firebox end.

The hornblocks are of cast steel with removable case-hardened iron or mild steel cheeks, with axle-boxes of forged or cast mild steel, case-hardened on the faces. The axle brasses are made from a mixture, 88 per cent. copper, 10 per cent. tin, and 2 per cent. zinc, with two white metal strips, 8½in. by 2½in., cast in slots on either side of the crown. The composition of the white metal is:—75 per cent. lead, 13 per cent. tin, 12 per cent. antimony. The boxes are lubricated by oil fed from the top by worsted trimmings. The pistons are of cast steel, with two rings ¾in. by $^{9}/_{16}$in., the piston-rods are 3in. diameter, with tail-rods 2in. diameter. The gudgeon pins are 3½in. by 3in., giving a bearing pressure on the projected area of 4400 lb. per square inch. They are of axle quality steel, having about .35 per cent. carbon.

The tanks are now built entirely by electric welding. The average daily mileage of these suburban tank engines is about 95, the coal consumption being 56 lb. per engine mile, or 28 lb. per 100 ton miles gross. The water evaporated averages 6.5 lb. per pound of coal.

Several years ago designs were prepared for a heavy eight-coupled suburban tank engine for handling the trains at increased schedule speed, but on account of the policy of electrification having been decided upon, and the fact that the axle-loads would have necessitated strengthening certain bridges, which are good for many years' life, their construction was abandoned.

MAIN LINE EXPRESS ENGINES.

The "N N" class, 4–6–0 superheated main line express engines, were first placed in service in August, 1914. Their cylinders are 22½in. by 26in., and coupled wheels, 5ft. 9in. diameter. The coupled wheel base is 14ft., and the total wheel base, 26ft. 3½in. The tube heating surface is 2040 square feet, the fire-box heating surface 165 square feet; total 2205 square feet. The superheating surface amounts to 547 square feet, and the grate area to 30.5 square feet. The working pressure is 180 lb. The engine in working order weighs 78 tons 3 cwt., of which 57 tons 19 cwt. are available for adhesion.

The superheater is a modification of the original Schmidt type; dampers and by-pass valves have been discarded. An air snifting valve is fitted in the saturated side of the header, and circulatory steam is provided by a special valve during coasting. The operating steam temperature is about 600 deg. Fah.

The valves are of the piston type, with inside admission. The gear is Stephenson's link motion. When these engines were designed, valve gears of Stephenson, Gooch, Joy, Allan, Southern, and Walschaerts types were in service on the New South Wales railways, and the choice of the Stephenson gear was principally due to its inherent characteristic, which gives an increased lead (with "open rods") when notched up. Piston-rod glands are packed with metallic packing of 20 per cent. antimony and 80 per cent. lead.

Recently a number of the "N N" class engines have had solid grease blocks fitted in the axle-boxes, and grease substituted for oil in the coupling-rods and big ends of the connecting-rods. The hard grease has been eminently successful, resulting in lower costs per engine mile for lubrication, and considerably less running shed attention to axle-boxes. The grease for rods is pressed into sticks of suitable diameter for the cups, which are fitted with a screwed plug and lock-nut. The plug is screwed down to squeeze grease round the whole journal at the commencement of a run, further feeding being automatic, owing to the softening of the grease when warmed. The grease-blocks for axle-boxes are moulded at a pressure of about 60 lb. per square inch, the shape being in conformity with the axle-box keep. The grease block is kept in contact with the journal by a plate and springs. A thin perforated plate covers the upper surface of the grease block, and controls the supply of grease to the journal, which is in contact with the grease only at the perforations. These allow the grease to feed upward when softened by the warmth generated in the perforated plate.

For trial purposes a solid ended connecting-rod has recently been fitted to one of the "N N" class. The big-end is in the form of a solid gun-metal bush drilled with a large number of small holes arranged spirally. The bush is free to rotate within a fixed steel bush pressed into the connecting-rod. The two rods in service have given complete satisfaction, having covered 35,000 miles without running hot, and with a negligible amount of wear. The rotating big-end bush is expected to reduce crank-pin ovalisation and give longer service without attention to the brass, the wear of which will be uniformly distributed owing to the rotation.

The crossheads are of the Laird type with a single and easily removable slipper white-metalled on both faces, the upper slide bar being considerably wider than the lower bar. The design provides a simple means of aligning slide bars and re-metalling the slipper, and also gives better protection against settlement of dust and grit than other types. It is also easily lubricated.

The exhaust steam injectors are of Davies and Metcalfe's manufacture, which on test on these railways have shown a fuel economy of 12 per cent. and a water saving of 18 per cent.

GOODS ENGINES.

The goods traffic has of recent years developed to such volume that trains of maximum tonnage can be hauled long distances without reforming or marshalling, and goods locomotive design has been and will be developed to increase the distance through which the locomotive may operate without receiving mechanical attention. The "K" class, 2–8–0, is the latest type, the first engine having been placed in service in November, 1918. The cylinders are 22in. by 26in., and the diameter of the coupled wheels is 4ft. 3in. The coupled wheel base is 15ft. 3in., and the total wheel base 23ft. 5in. The boiler, like that of the "N N" class, has a coned back ring, and carries 160 lb. pressure. The tube heating surface is 1582.5 square feet, fire-box surface 174.4 square feet; total, 1756.9 square feet; superheating surface, 4414.8 square feet; grate area, 28.75 square feet. Weight in working order, 72 tons 19 cwt., of which 66 tons 1 cwt. are available for adhesion.

These engines have the Southern valve gear, which, being outside, is readily accessible. The grates are of the rocking finger-bar type.

The superheater is of Mr. Lucy's design, and has obviated troubles associated with other types. Cast steel "fingers" with faced joints are bolted to the cast iron header, and the elements, which are perfectly straight, are expanded into these fingers. This arrangement does away with flanged joints, provides for all elements being alike, and gives increased life of elements. It was found that many of the older bent elements failed owing to the steam scoring them through at the bends. Moreover, under the new arrangement, a burst element can easily be plugged.

The truck differs from that used in previous 2–8–0 engines in that the journals are placed outside the wheels in order to obtain better access to the axle-boxes and springs. Grease is used for lubricating the coupled wheel axle-boxes, coupling-rods, and connecting-rod big-ends.

Additional blow-off cocks are fitted to the boilers to enable solid matter to be blown out under steam instead of dropping the fire and washing out the boiler every trip in certain bad-water districts.

The first engine of the "K" class achieved a remarkable performance in working a train from Sydney to Wallangarra and back, nearly 1000 miles, without any running shed attention of any kind.

FUTURE DEVELOPMENTS.

The enlarged loading and structural gauge, which is now being adopted, will allow the use of engines of greatly increased capacity. The first type of engine which will be built to suit these conditions is a 2–8–2 (Mikado) goods engine, capable of hauling trains 33 per cent. heavier than those taken by the "K" class, and at about 12½ per cent. greater speed. These engines will have 23½in. by 28in. cylinders, and 4ft. 7in. coupled wheels. Bar frames have been adopted, as experience has shown that the limit for economical construction has been reached with plate frames under the conditions prevailing in New South Wales. Now that reliable steel castings can be readily produced, bar frames possess the inherent advantage of allowing reasonably exact proportioning of sections throughout their length in accordance with the stresses to which they are subjected. Both thickness and depth are variable at any point, whilst the spring suspension and compensating beams can be better arranged. Further advantages are gained in the improved fixing of cylinders, and better arrangement of wide fire-box and hopper ashpans.

On account of the width of the fire-box, the brick arch will be supported on arch water-tubes of the American type. Experiments are now being undertaken with calorised superheater elements, and it is probable that this system will be adopted as standard.

The boiler is of the coned type, the barrel being 5ft. 6in. diameter inside at the front and 6ft. 2in. diameter at the back ring.

The rotating bush, which has been so successful in the "N N" class will be adopted for the big-ends, and probably also for the main crank pin bushes in the coupling-rods. Grease lubrication will be fitted throughout the axle-boxes.

A further improvement likely to be incorporated is a self-cleaning smoke-box, designed in accordance with practice developed by the Pennsylvania Railroad after considerable research work. The front-end arrangement also permits of a larger blast-pipe orifice.

The valve gear is of the "Southern" type, which has proved very satisfactory on the 2–8–0 engines of the "K" class, particularly in regard to low cost of maintenance.

Following the "Mikado" locomotives will be a 4–6–2 engine for handling heavy passenger trains. Here again the principal departure in proportions is the use of considerably augmented boiler capacity per unit of cylinder volume to enable high tractive power to be maintained at considerable speed, a necessity with the heavy grades on the main lines. The tractive effort will be 32,100 lb., as compared with about 30,230 lb. for the previous "N N" class, but the driving wheels will be 6ft. 3in. diameter in the case of the new engines. The cylinders will be 22½in. by 28in., and the valve gear will be of the Walschaerts type, which the author considers to be the most suitable outside valve gear for express engines. The main driving axle of a passenger engine is subject to considerable vertical movement relative to the frame, when passing at high speed over irregularities in the road, and this movement affects the steam distribution with a gear like the "Southern," which operates the valve by the vertical projection of the excentric path, whereas with the Walschaerts gear the effect is inappreciable, as the valve is controlled by the horizontal projection of the excentric circle.

Both the "Mikado" and "Pacific" engines are designed to undertake long trips without shed attention, and it is confidently anticipated that with the latter the run of 401 miles—Sydney to Albury—will be possible without changing engines, though, of course, the crews would have to be changed at an intermediate station.

STANDARDISATION.

During recent times much has been written concerning standardisation of locomotive designs. Many people have advanced theories regarding possible savings to be effected by constructing all locomotives to designs known to be satisfactory, but in practice even the largest users are quite unable economically to prevent the number of classes of engines increasing. Locomotive design has never remained stationary. The progress of invention has continually developed improvements leading to economic gain, either in operation or maintenance, and at present there are no reasons to believe that we shall attain the most efficient possible design of locomotive in the near future. Hence standardisation would entail refusing to take advantage of lessened costs, which experience has shown to be generally advantageous, after providing for additional charges brought about through varying the design.

Roads in North China.

(Contributed.)

DURING the past year the British manufacturer of roadmaking machinery has heard a good deal concerning road construction in China, and doubtless has conjured up in his mind visions of large orders consequent on the linking up of various centres in the northern provinces. The following information and remarks are intended to show that development along this particular line must of necessity be slow, especially in view of the fact that the majority of the roads in a more or less completed state have been built partly or wholly by charity funds, this invariably taking the form of donations from the Red Cross Famine Relief Association. It followed that the purchase of relatively costly machinery was out of the question, the essential problem being how to feed the maximum number of mouths.

The further problem of maintenance will be better understood just as soon as it is realised that it depends largely on efficient organisation coupled with local effort, conditions which are not easy to obtain. It is fairly safe to assert that the Chinese highway, consisting of two parallel cart ruts, has existed for centuries, and in the circumstances the average Chinese entertains lax ideas concerning excellence of road surface and all that it means in the development of motor traffic. The accompanying illustrations and those on page 683 show the present condition of some existing roads.

Peking–Tientsin Road.—Peking–Tungchow section, 12 miles. This road was laid down some considerable time before any real organised attempt was made to push the road through to Tientsin. Fig. 5, page 683, shows a typical ornamental bridge on this section. It is historically interesting, as being the spot where the British and French soldiers, taken prisoners by the Chinese in 1860, were executed. Fig. 4 gives some idea of the native cart ruts, from 12in. to 15in. in depth; while in Fig. 3 the road is seen crossing a small stream outside the south gate of Tungchow. Fig. 1, taken in Tungchow, shows the edge of the road breaking away. At this point the road has been decreased in width to such an extent as to make it almost impossible for a car to pass.

It may be of interest to recall the fact that this highway was first proposed in 1917 by the American Flood Relief Committee, the American Red Cross to give 100,000 dols. for the payment of flood sufferers as labourers, and the Chinese Government to give an equal amount in materials. Further, the Chinese authorities concerned were to arrange the right of way—always a ticklish business when it comes to the desecration of ancestral graveyards. At this time political conditions in China hampered progress and only the first section to Tungchow was completed. In 1919 the Banque Industrielle de Chine advanced a loan of 250,000 dols. for the completion of the road to Tientsin, but this sum was found to be insufficient, and the American Advisory Board contributed a further 50,000 dols. and later a still further 100,000 dols. This money would have seen the road through to Tientsin, but after Yangtsun was reached, a few miles from Tientsin, the Chief of the Police of the latter place threw a native foreman and gang of coolies into gaol because money for the right of way in an area coming under his jurisdiction had not been paid. The storm of criticism following this arbitrary action was kept up in the foreign Press for some weeks, and it was arranged that all foreign firms should give their advertising space to a plain-spoken demand for a good Peking-Tientsin road until such time as the said Chief of Police modified his course of action. This he did eventually, even to the extent of completing the road with his own forces and borrowing the necessary money—some 70,000 dols.—for the purpose. In July of this year the writer made an attempt to get on this road from the Tungchow end, but found it almost impossible to do so. The surface was cut up to such an extent as to make it impossible for one to believe that any attempt had even been made to keep it clear of the narrow-tired native carts.

It is now stated on good authority that the Tientsin-Tungchow section has been repaired and that a local motorist recently completed the journey from Tientsin to Peking in from four to five hours. Motorists have to pay a road tax of 50 dols. for cars and 15 dols. for motor cycles, in addition to the usual tolls. It is now probable that the hard rolled earth surface will remain in fairly good condition during the winter months and until next summer's rains.

Peking Roads.—The roads running from Peking, in addition to the Tientsin highway, are:—(A) South to Nanyuan to the aviation ground and camp, 6 miles approximately; (B) Summer Palace at Wan-shou-shan (Hills of Ten Thousands Ages), 11 miles. Pa-ta-ch'u, Jade Fountain, Pi Yun Ssu, and all the show places on this side of Peking. This road, which was constructed for the late Empress Dowager, was paved with large stone setts; these have since been removed to the outsides, leaving a soft centre carriage-way. It connects with the road from the P'ing-tse Men (Gate of Just Law) running out through Pa-li-chuang. (C) Hsi Pien Men (West Convenient Gate) to P'ao Ma Ch'ang, the racecourse, where the summer residences of the Europeans in Peking are situated. This road also connects with the Pa-li-chuang–P'ing-tse Men road.

* See map in THE ENGINEER of November 3rd.

SHANSI ROADS.

*Taiyuanfu, Taiku, Pingyao, Hankow Pass, Puchowfu.**—In August of this year and immediately following fairly heavy rains in this district, the writer made three attempts in as many days to get out on to the Yutzu or Fenchowfu sections, but failed to do so even when using two coolies to the one rieksha. It is no exaggeration to say the roads did not exist and the quagmire outside the city gate extended as far as the eye could see. Fig. 6, page 683, shows the road inside the city, taken from the gate, and although the road surface is not too clear, the deep ruts full of water are apparent. And yet this is in excellent condition compared with the majority of provincial roads that have been built with Red Cross famine funds, and incidentally, let it now be said, allowed to go to pieces. Fig. 2 shows the customary neglect even in a main street running north and south through Yutzu, one of the most important commercial centres in the province. Yutzu is a walled city, and prior to 1913, when the Chengtai Railway was completed, goods were forwarded to this place from the Chihli province for distribution.

*Pingyao, Fenchowfu–Yellow River.**—This is considered to be the most commercially important of the roads so far constructed in Shansi, and originally was intended to give a water outlet to a rich district. The writer has been informed by European residents in Shansi that at the present time there is little or no real traffic for such a route, and that it would have been better policy to have expended the money on the general improvement of the Peking, Tientsin, Paotingfu, Shansi circle of roads. The levels on the Pingyao-Fenchowfu section do not vary more than about 20ft. in as many miles. It has a width at the top of 22ft. and an average height above the surrounding land of about 3ft, while the surface is composed chiefly of ashes. The only bridge of any importance on this section, viz., the crossing of the Fen Ho, is more or less of a temporary structure and so arranged that if damaged by floods it can easily be repaired or replaced.

The Fenchow-Yellow River section was a far more difficult piece of work. From Fenchow (altitude 2200ft. approx.) there are gradients of 1 in 35 to 5300ft. at 25 miles. The geological formation of the area is largely volcanic with overlying deposits of loess. Some of the embankments and filling-in work have depths of as much as 80ft. to 100ft., and cuttings varying from 50ft. to 70ft. run for long distances, partly through the wind-desposited loess and partly through base rock, especially in wind-scoured areas. In this section there are more than twenty bridges and 450 culverts.

*Yangchuan (Chengtai Railway) Liaochow.**—This road passes through the richest coal, iron and pottery districts in China. It starts from Yangchuan, on the Chengtai Railway, at an elevation of between 2000ft. and 3000ft., crosses elevations at 3000ft., 4000ft. and 5000ft., and then drops down to Liaochow at 3500ft. approximately. The work was finished in six months at a cost of well over 6500 dols. per mile. This road has an average width of 20ft. or 30ft. on sharp curves or peaks, and is carried over no less than 230 bridges and culverts. Across loess areas the surface consists of this material tamped hard. In the vicinity of native furnaces slag is used, and in other parts stones are well tamped. Some of the gradients are 1 in 12 or 13, but only over very short lengths, and, according to reliable reports, at least 80 per cent. of the road has easier gradients than 1 : 20.

*Fenchowfu, Wensia, Taiyuanfu.**—This road runs along the lower slopes of the hills and only a little above the level of the plain. The only difficulty met with was north-east of Wensia, in crossing a tributary of the Fen Ho. The bridge consists of twelve spans, each of 20ft.

SHANTUNG ROADS.

(1) Roads in Tsingtao, and in fact the whole of the territory leased to Germany in 1898, are the best in China proper. The principal streets and roads in the town itself and the main road which runs round the shore to the Strand Hotel, situated near the fine bathing beach, have a tarred surface—see Fig. 7, page 683. Beyond these limits all roads are macadamised and are kept in a splendid state of repair. Figs. 8 and 9 show sections of the road running past the bathing beach to the wooded hills on which the old German forts are situated. These roads connect with the system which extends beyond the line of fortified hills, Spandau, Iltis, Bismark, &c., and the waterworks to Laoshan, a maximum of some 30 miles—see Figs. 10 and 11. Prior to the Japanese taking over in 1914, the Germans laid about 2½ miles of asphalt roads and 45 miles of macadamised roads. To these the Japanese have added 10 miles of asphalt and nearly 20 miles of macadamised streets, all lying within the new industrial area some 2 miles north of the residential and shopping quarter of the town. Further out in the leased territory the Japanese have increased the length of macadamised roads put down by the Germans by 60 per cent. approximately. Chinese hand carts, &c., are not allowed on the macadam surface and have to keep to the track provided. This track consists of granite or stone setts, one line forming an extra width to the gutter setts, the other line being let in flush with the road surface at a distance to suit the average gauge of carts. River crossings on the roads outside Tsingtao are really pavements and usually consist of granite setts of fairly large dimensions cemented together and levelled, the surface being only a few inches above the river bed. On the up-stream side smaller setts, carefully arranged, but without fixing, up to a width of, say, 6ft., are intended to protect the road surface against flood waters. It must be remembered that these river beds are quite dry for at least eleven months in the year, and that sudden rushes of water caused by storms in the adjacent hills usually do not last for more than a few hours.

(2) Wuting, south-west to Yucheng, where it cuts the Tientsin-Pukow Railway, about 25 to 30 miles north-west of Tsinanfu to Tungchangfu, situated on the Grand Canal, a total length of about 120 miles. This is a new Red Cross road, and two Chinese companies, each capitalised with 500,000 dols., have arranged to operate an omnibus service, one from Wuting to Yucheng, and the other from the latter place to Tungchangfu.

(3) Chefoo-Weihsien Road,* from the former place to Tungchowfu, the most northerly point on the Shantung promontory, south-west to Laichow, and on to Weihsien, a station on the Shantung Railway about midway between Tsingtao and Tsinanfu. This road was constructed by the Ministry of Communications, but although many more roads were projected, it is difficult to see how the Chinese Government can continue the work in its present hopeless financial position. The rendition of Wei-hai-wei may

FIG. 1 EDGE OF ROAD BREAKING AWAY

FIG. 2 EXAMPLE OF NEGLECTED ROAD

SOME BAD AND GOOD ROADS IN CHINA

FIG. 3—ROAD CROSSING STREAM OUTSIDE TUNGCHOW

FIG. 4—RUTS CUT BY NATIVE CARTS

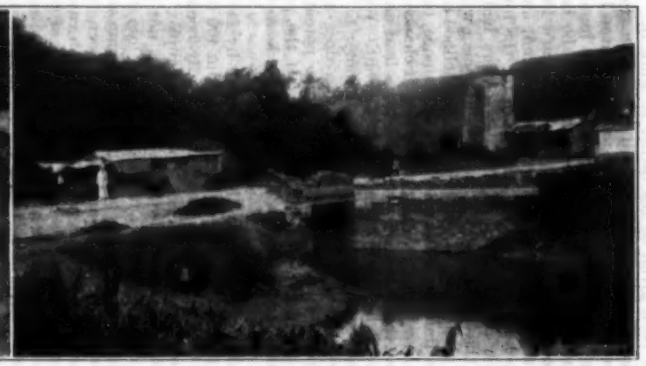


FIG. 5—TYPICAL BRIDGE ON PEKING-TIENTSIN ROAD

FIG. 6—RUTTED ROAD INSIDE A CITY

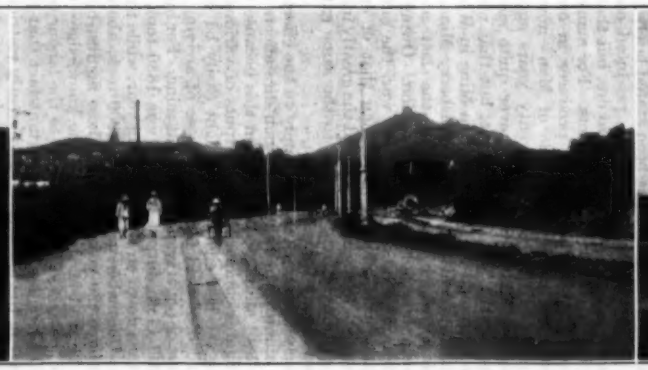


FIG. 7—ROAD TO STRAND HOTEL, TSINGTAO

FIG. 8—ROAD BESIDE BATHING BEACH, TSINGTAO

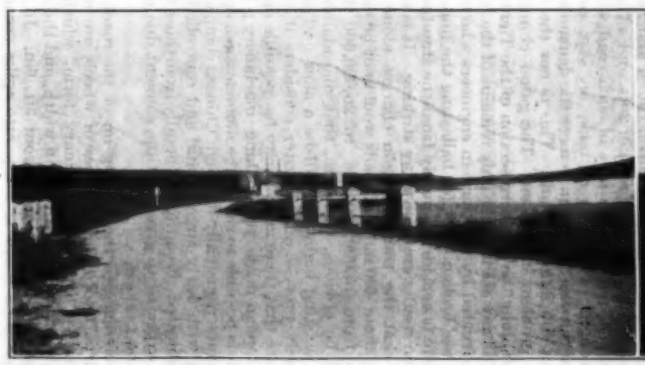


FIG. 9—ROAD TO THE BATHING BEACH, TSINGTAO

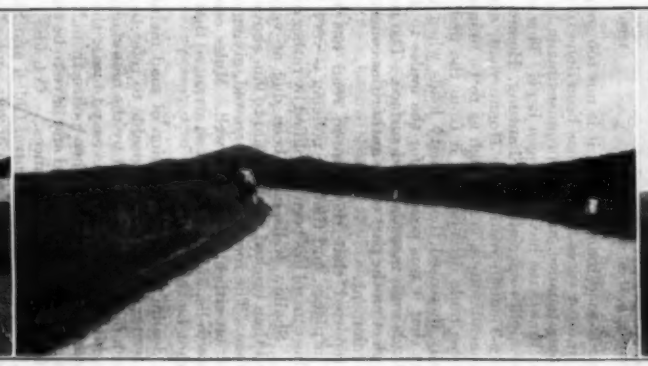


FIG. 10—THE ROAD FROM TSINGTAO TO LAOSHAN

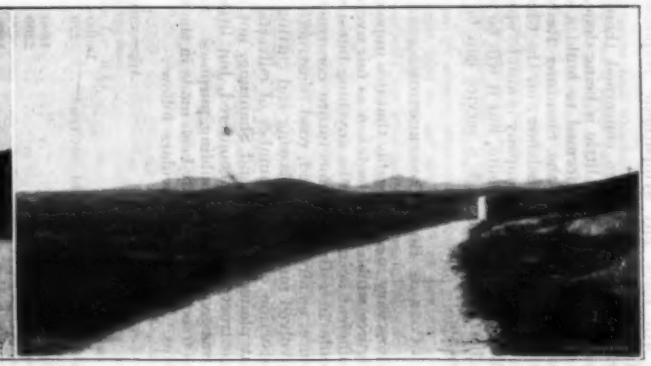


FIG. 11—THE ROAD FROM TSINGTAO TO LAOSHAN

stir the local patriotic gentry to do something, especially as one of the essential conditions to be complied with is the linking up of the port with the interior. For reasons which need not be discussed here, a railway is out of the question and good roads would meet the case. It remains to be seen whether the Chinese will show any sympathetic response to England's offer.

So far as other centres are concerned there are plenty of rumours, but very little is being done. A Chinese company has been formed to build a road from Lantsun, a point on the Shantung Railway, north to Pingtu and on to Laichow, on the Chefoo-Weihsien road. The same company is also to operate an omnibus service on this route, but it will be some considerable time before such a service can be put into operation.

Cost of Road Construction.

Conditions vary so considerably that it is impossible to give figures which could be taken as fair averages and of sufficient accuracy to be anything but a very rough guide in estimating for future construction. For instance, as already stated, road construction in Shansi involved much rock blasting and cutting and the construction of a large number of culverts, but in the flat plains of Chihli and Shantung, not only were large tracts of sand encountered, but little or no clay was available for building purposes. Some references to cost have already been made in the foregoing notes. Further particulars follow:—

Road.	Approximate cost per li (3 li = 1 mile). Dollars.
Tientsin–Paotingfu, over old cart track ..	220
Peking roads where—	
Macadamised	1500
Shansi dirt	2200
Shantung dirt	600
Tamingfu, Hantan, Wuan dirt	1200

As regards road maintenance, it is not too soon to say that in most cases nothing has been done to provide for maintenance, and the promises made to the American Red Cross have not been kept. This state of affairs applies specially to Shantung, Honan and the Peking-Tientsin road. The Honan road, one of the few macadamised, is so rough as to be unusable. The Chinese mule drivers used it from the first and incidentally increased the ordinary loads when they found out that it was possible for the mules to draw heavier loads on a macadamised surface. The result of this neglect on the part of the authorities concerned needs no comment.

It is reported that the Hantan road has been repaired in places, and that the policing is very well done. This control has been simplified by rather novel methods. Shallow wells have been dug at various places and then bricked up, say, 6in. to 9in. above the road surface. The road is also narrowed, giving only about 2ft. on either side of the well. Mules cannot cross these wells, and the road is so arranged that the carts cannot be turned out.

Whilst dealing with the question of road maintenance the writer considers it advisable to refer to one point which may be lost sight of by the manufacturer of roadmaking machinery. It is easy to raise the cry "Macadamise the roads and then police them," but materials are not always to hand and have to be transported from immense distances. Consider, for example, the mud roads in Central Chihli and Shantung. Assuming a width of road of 20ft. and a thickness of 9in. of macadam, a mile of such road would require roughly 2500 tons of rock, or, say, seven goods trains a day for a year to meet the demands for more than 400 miles of roads. This is not the first time the problem has arisen. The gaunt chimneys to be seen along the northern section of the Tientsin-Pukow Railway are now the only remains of the brick kilns constructed by the German engineers who were forced to use broken brick for ballasting the line. If the problem is considered purely from the standpoint of cost, the results are even more striking. It is easy to show that the transportation charges alone for metalling about 400 miles of roads would not be much less than from 15,000,000 dols. to 20,000,000 dols. It should be obvious, therefore, that macadamising even the existing highways will be a slow and relatively costly process. The writer considers it only fair to state that there are, or may be, possible openings for foreign-made roadmaking machinery; but so far as it is possible to say at the moment such openings will come principally through Chinese companies operating with fairly large capital and controlled by Chinese educated abroad, and generally from those who could be expected to give the time element due consideration.

With reference to the cutting up of the roads by native carts, two different types of wheels are used on the native cart: the ordinary form, which is fitted with a flat iron tire 1¼in. in width, and the saw tooth type. The diameter is about 3ft. 6in. In the latter type each tooth is a separate spike securely fixed into a flat tire and in shape resembles a truncated square pyramid, the area produced by truncation forming the outer surface. Actual measurements show that this area does not exceed about 0.3 square inches. The teeth touch all the way round. As the Chinese cart is always a solidly built conveyance without springs, it is not a difficult matter to realise that the best roads will quickly go to pieces unless they are efficiently policed.

As regards the immediate future little can be said. Some writers have suggested the elimination of the narrow tire by means of a Government subsidy, but it is manifestly impossible for any Government that cannot pay either wages to its railway workers and city police or salaries to its university teachers, to put up the necessary money. For the time being at least, unsettled conditions make it impossible for any authority to carry out a united and comprehensive scheme.

Note.—All costs given in these notes are Mexican dollars. Present rate of exchange £1 = 8 dols., very approximately. The normal pre-war rate was about £1 = 10 dols.; during the war it rose to £1 = 3 dols.

The Mill Close Lead Mine.

The reported sale of the Mill Close lead mine, which is situated near Darley Dale Station, Derbyshire, to certain London mining interests—the New Consolidated Goldfields, Limited, the National Mining Corporation, and the Zinc Corporation—is a matter of interest in British lead-mining circles generally, while to Derbyshire it is a move of the greatest importance. The sale is a direct outcome of a report made by Dr. Malcolm MacLaren, the mining geologist, and it is not the first time that he has reported on local lead-mining potentialities on behalf of London interests. In previous cases we understand the difficulty has been to obtain a property large or important enough to justify the attention of financial groups, the Mill Close Mine up to quite recently having been firmly held by the Wass Trustees as a most valuable property. It has been stated lately in print that this mine produces or has produced one-third of the total British output of lead ore, but that statement is not supported by the facts. For many years, however, it was the premier producer in our isles, succeeding Foxdale Mine, Isle of Man—now, alas! no more—in that position twenty years ago. The Rhosesmor Mine, Flintshire, never quite succeeded in topping the Mill Close output, but that was done a few years ago by the Boltsburn Mine in Weardale, and more recently by the Queensberry Mine, Dumfriesshire, which, according to the last available statistics, now holds the first position. Owing to the withdrawal of labour during the war, the output of one mine was affected more than that of another, according to local conditions, and the greatly increased costs of mining were not felt to the same extent in all lead-mining fields.

Nearly the same remarks apply to the effect of the trade slump, which has had such dire effects on our home lead mining. We mention this because we feel that figures comparing the outputs of various mines during the last eight years might easily be wrongly construed, if used for the purpose of arriving at the richness or poverty of this or that mine. For instance, the Mill Close output in 1920 was 1880 tons, about 1000 tons down on the preceding year, while the yield of the Queensberry Mine was 2900 tons, about 1000 tons above the year before. These figures, however, must be read in the light of the knowledge—not, of course, possessed by everyone—of the labour troubles at Mill Close, and of the important fact that the rise of water in the lower levels had greatly restricted the area of activity. Water at the bottom of a mine with proved reserves does not frighten the mining engineer or astute investor, and our only object in mentioning it is by way of explaining figures which may easily be wrongly interpreted. Unlike the many large producers of past days in the North of England, the lower levels of Mill Close cannot be drained by adit, and the pumps have always been a prominent feature of the mine. We are not in the secrets of anyone connected with the present movement, but as the limestone beds containing the productive flats are dipping under the overlying Yoredale shales, any scheme of development must assuredly lead to the working of deeper ground, with the contingency of increased pumping costs. There is nothing alarming in this prospect, because if analogy goes for anything, the geological horizon is the very best for anticipating success. Capital on no parsimonious scale will certainly be necessary, and its provision and expenditure on sound lines is a matter of paramount importance.

Progress here will also be of the greatest interest in other parts of the Peak District, where insufficiency of funds to cope with increasing water difficulties have led in the past to the abandonment of mines in most promising ground. It will hardly be disputed that the days of the small man's mine are past, all available outcrops having been worked out to water level, and the advent of the big man with ample capital seems to be absolutely necessary if the industry is to survive and make progress. A rather important fact about the Mill Close Mine is that the present workings are just outside the King's Field, in which the King takes the lead dues of lot and cope by right of his Duchy of Lancaster. The royalties of Mill Close belong to the owner of the land, and the property generally is not subject to the provisions of the Derbyshire Mining Customs and Mineral Courts Act, 1852. It is not sufficiently known outside mining circles in the county that the "gift" of a mine by the barmaster to an individual is merely the right to mine lead ore on payment of the royalties mentioned above. There is nothing in the nature of a freehold, and anyone else can claim the mine if it has remained unwrought for three weeks after notice has been given to the owner to work it. When the Wass Trustees sold the Mill Close Mine two or three years ago to Mr. Chambers, of the Stanton Ironworks, they abandoned their rights to over a hundred other mines which stood in their name in the barmaster's books, these mines being in the King's Field. The mining rights were put up for auction, and fetched the large sum of, we think, £15 for the lot—not for each mine, as one of the newspapers had it. Any of these mines which are not now being worked may be claimed by anyone else who is inclined to shoulder the financial responsibilities of damage to property or livestock by caving in, on the off chance of finding that the old men have left a little lead above water level which can be mined at a profit. We mention these facts because the mine promoter of the baser sort who obtains his title for 25s. does not always explain as fully as he should do to potential speculators how precarious the tenure of the property is compared with what obtains when a lease is granted by the landowner.

Although galena, the lead ore, is by far the most important product of Mill Close, from 400 to 500 tons of blende, the zinc ore, have usually been obtained annually. This being, however, complex with iron pyrites, it is a question whether it is not a liability as much as an asset from a profit and loss standpoint. The smelting works belonging to the mine are situated some miles away, and it is or has been from these works that the agent sallies forth with cash in hand to the small man's mine, where a sale of the dressed ore is conducted, with the compulsory assistance of the barmaster, who measures the ore in the standard dish and takes the King's dues, to which in some cases is added the burden of a vicar's tithe. However small the amount of ore on sale, Wass never refused to send an agent to pay cash for it, and it is a matter of surmise now whether the new powers that will be in control will perpetuate the Wass custom, and always be ready to purchase small lots of what, it must be confessed, is often decidedly low-grade ore.

In an earlier paragraph, we ventured to question the statement that Mill Close produces one-third of the British total of lead ore, and perhaps we may usefully supplement our query with some figures.

In 1902 Mill Close yielded 3500 tons, out of a total 24,606 tons; in 1903, 4500 out of 26,567; in 1906, 5500 out of 30,795; in 1909, 5000 out of 29,744; and in 1910, 6300 out of 28,534. That was the bumper year, such a high yield not having been reached since. In 1914 the yield was 4300 out of 24,282, and in 1920, 1880 tons out of 15,399. Although the exact ratio of the mine's output to the total output is a matter of very little importance, the above figures show that the mine has for long had an important part in British lead ore production, and more than that, it entirely refutes the statements made by ill-informed persons that Derbyshire lead mining is dead. In only two years in its long history has the county's output attained to 10,000 odd tons—1859 being the year of highest yield. Mill Close—or, to be correct, the resuscitated Mill Close Mine—began to yield ore in 1861, and has always played the major part in keeping the county's output up to a respectable total, it being, of course, undeniable that the general and widely spread mining activities of the middle of last century have suffered almost a total eclipse. Now that the eyes of Londoners have been focussed upon mining in the Peak, it is possible that resources may be forthcoming for the development of other mines which can hardly be said to have had a real chance when closed down in the more or less distant past.

A Study of Air-Steam Mixtures.*

By L. A. WILSON and C. R. RICHARDS.

(*Concluded from page* 664.)

History of the Study of Air-steam Mixtures.

The use of air and steam combined as a medium for developing power is not of recent origin. The value of air in preventing rapid condensation of steam was known by Savery and other scientists before 1800 and was utilised by them in the operation of water pumps by interposing a layer of air instead of a piston between the steam and the water.

Reports of the United States Patent Office show that during the past century attempts have been made to patent an air-steam engine and that several patents have been granted. Very few, however, have been given prominence by means of discussion in engineering literature. George H. Babcock, in a paper entitled "Substitutes for Steam," presented to the American Society of Mechanical Engineers in 1885–6, reviewed the various attempts to establish the use of this novel means of driving prime movers.

In 1872 W. J. M. Rankine† published an article entitled "Remarks on the Theory of Air and Steam Engines," in which he pointed out that the air has a tendency to increase the efficiency of the mixture, independently of any addi-

* From Bulletin No. 131 of the Engineering Experiment Station, University of Illinois, Urbana.

† The Engineer, November 1st, November 22nd, December 6th, and December 27th, 1872.

tion of heat, by widening the working temperature limits of the steam.

In 1873 Osborne Reynolds made an investigation to ascertain the effect of a small quantity of air on the power of a cold surface to condense steam. The apparatus employed consisted of a glass flask, in which a surface condenser was formed by a copper pipe passing in and out through the cork. The pipe, which was kept cool by a stream of water, was arranged so that all the condensate discharged from it in drops which could be counted. Reynolds reached the following conclusions :—

(1) A small quantity of air in steam greatly retards condensation upon a cold surface. On the other hand, there is no limit to the rate at which pure steam will condense except the power of the surface to carry off the heat.

(2) The rate of condensation diminishes rapidly and nearly uniformly as the pressure of the air increases from 2 to 10 per cent. of that of the steam. It then diminishes less and less rapidly until a pressure of 30 per cent. of that of the steam is reached, when the rate of condensation remains nearly constant.

(3) In consequence of this effect of air the necessary size of a surface condenser for a steam engine increases very rapidly with the quantity of air allowed within it.

(4) If air is mixed with steam before it is used, the condensation at the surface of a cylinder may be greatly diminished, and consequently the efficiency of the engine is increased.

(5) The maximum effect in diminishing condensation will be obtained when the pressure of the air is about one-tenth that of the steam, or when about 2 cubic feet of air at atmospheric pressure and with a temperature of 60 deg. Fah. are mixed with each pound of steam.

The most potent cause of the reduced condensation of steam when mixed with air is the separation of the molecules of the steam by the molecules of the air. Evidently there can be no condensation of the steam unless its molecules coalesce ; furthermore, the steam when mixed with air is converted into superheated steam, and therefore recedes from the condensation point.

According to Dr. A. Stodola, the physicist Pictet suggested the use of heated compressed air mixed with steam to lower the temperature drop of a non-condensing steam engine. Pictet concluded that the steam consumption of a non-condensing engine, operated with an air-steam mixture of about 2 to 1, would approach nearly that of a condensing engine.

There appear to be two general classes of air-steam engines hitherto invented, depending upon the method of providing a mixture of air and steam. In one case the mixture is formed within the boiler, while in the other the air and steam are mixed at or near the engine. The first method involves such means as the following :—

(1) Injecting the hot gases from the chimney or uptake into the boiler under pressure.

(2) Operating the furnace under a pressure sufficiently high to force the gaseous products of combustion into the boiler without further compression.

(3) Forcing air into the boiler to mix with the steam.

By any one of these means energy is required to pump or inject the air or gases into the high-pressure steam. The device used for this purpose has been an injector, a pump connected to the engine, or a pump driven independently.

The first of the various attempts to use the products of combustion mixed with steam which received the attention of the engineering profession—in 1827—was an invention by Minus Ward, of Baltimore. Similar inventions appeared from time to time, but no practical application was made until 1856, when a large locomotive constructed upon this principle was tried on the Erie Railroad. Owing to the deleterious effect of the ashes and intense heat on the cylinder walls of the engine, the test failed. The theoretical aspects of an engine of this design are interesting, and they show the efficiency which might be attained if it were possible to overcome the practical operating difficulties. The theoretical efficiency of such an engine was studied in detail by J. A. Henderson for his graduation thesis at Stevens Institute in 1873. The thesis was published by Professor Thurston in his report on "Mechanical Engineering at the Vienna Exhibition in 1873," and printed in abridged form in the *Journal* of the Franklin Institute in 1874. The following were Henderson's conclusions concerning the most advantageous use of mixed air and steam in engines utilising the entire products of combustion :—

(1) When a moderate value for the initial temperature of the mixture, t_1, is required in order to avoid making provision against the effects of heat, comparatively high initial pressure, p_1, and as small a supply of air, N, as possible are the most advantageous conditions for yielding the highest efficiency consistent with the given temperature, in addition to high mean effective pressures, with a moderate size of pump.

When the initial temperature is high there are two additional cases.

(2) The retention of a high mean effective pressure and a small pump with the maintenance of high efficiency demands that the initial pressure of the mixture p_1 remain high and that the supply of air N be kept at a minimum. This case is equivalent to the preceding one, except that the temperature t_1 is raised.

(3) If the highest efficiency is required, at the expense of an increased bulkiness of the engine, the initial pressure of the mixture p_1 may be reduced and the supply of air N increased.

A scientific investigation to determine the practicability of utilising the products of combustion mixed with steam was undertaken by C. M. Garland in the Mechanical Engineering Laboratory of the University of Illinois from 1905 to 1907. The "constant pressure generator" devised for this investigation used liquid fuel, which, of course, gave no trouble from ash. Difficulties arose, however, which made the tests incomplete.

The plan of providing a mixture by forcing high-temperature air into the boiler from coils of pipe in the hot flue was given a great deal of publicity about 1870.* There seems to be some contention as to the originator of this plan, but George Warsop, of Nottingham, England, was active in promoting it as his, and it became generally known as "Warsop's System." The plan was brought to the attention of the British Association in 1869 by Richard Eaton, who presented a paper on the subject a few months later to the Institution of Mechanical Engineers. Economy tests were reported, all of which indicated wonderful results in favour of the "system" as suggested by the following data :—

Even Pressure Trial.

	Air and steam combined.	Steam only.
Coal consumed	112 lb.	112 lb.
Weight of brake	120 lb.	120 lb.
Duration of experiment	153 min.	112 min.
Revolutions of brake	15,433 total	10,500 total
Revolutions per minute of brake	101	93.75
Gross horse-power of useful work	972.55	661.79
Water evaporated	93.75 galls.	68.75 galls.
Weight of fire left in furnace	53.5 lb.	34 lb.

Open Valve Trial.

Coal consumed	140 lb.	140 lb.
Weight of brake	120 lb.	120 lb.
Duration of experiment	234 min.	196 min.
Revolutions of brake	22,815 total	17,825 total
Revolutions per minute of brake	97.5	90.94
Gross horse-power of useful work	1428.05	1115.7
Water evaporated	131.25 galls.	112.5 galls.
Weight of fire left in furnace	43 lb.	28.25 lb.

The gain in power in the even pressure trial by using air and steam combined was 47 per cent., in the open valve trial 28 per cent. Tests in two different ships showed a saving of 27 per cent. and 30 per cent. respectively in fuel consumption because of the air injection. Later tests with stationary apparatus gave results as follows :—With fuel consumption of a Nottingham boiler per horse-power per hour with steam alone was 5.53 lb., while with air injection the fuel consumption was 3.40 lb., a saving of 38 per cent. With a London boiler using steam alone the fuel consumption was 5.88 lb., and with air injection it was 4.72 lb., a saving of 20 per cent. Other brake tests showed gains of 24.5 per cent. at a speed of 117 revolutions per minute and 33.5 per cent. at a higher speed.

Warsop's system was finally adopted by the Lancashire and Yorkshire Railway and also installed successfully in several vessels. It was reported that 10 or 12 per cent. of air in the mixture gave the best results. The principal advantages claimed for the system, apart from those which might result from mixing air and steam, were increased boiler efficiency from agitation and from better circulation of the water and prevention of incrustation and priming.

The second plan of providing a mixture for air-steam engines, that of introducing the air after the steam has left the boiler, was described by William H. Shock, Chief Engineer, U.S.N., in a paper published in the *Journal* of the Franklin Institute in 1854. The engine was invented by William Mount Storms, of New York, and was commonly called "Storms' Cloud Engine." Air compressed to approximately 18 lb. pressure was admitted to the cylinder at the beginning of the stroke for about 1.5in. of piston travel ; then steam at 80 lb. pressure was admitted during the next 2in. of piston travel, when communication to the cylinder was closed and the mixture expanded. The test reported shows an increase in power due to mixing of more than 50 per cent. In the light of present knowledge, however, some of the statements made regarding the operation of the engine lead one to discredit this report.

Certain experiments by T. McDonough, of New York, pertaining to the effect of mixing air with low-pressure steam, were reported in 1865 by the *Journal* of the Franklin Institute. Steam was generated in a small boiler and allowed to escape through a nozzle and to strike upon the fan of a small air mill. The quantity of steam used in a given time and the speed of rotation produced were noted ; then air under moderate pressure was allowed to flow from a gasholder into the rear of the jet and to issue with the steam. From the amount of air added and the rotative speed of the mill it was found that the addition of about one part of air to ten parts of steam would increase the number of revolutions of the mill by one-fourth. It was suggested as an explanation that "the introduction of cold air might condense some of the steam, so causing it to be projected in liquid drops against the wheel, by which means its motive power would be more efficiently applied than when it issued as an expanding and diffusable vapour."

At about the same time facts similar to those just given were observed in connection with the operation of a small steam turbine by R. E. Rogers, of the University of Pennsylvania.

Early in 1867 there appeared an announcement of Parker's steam and air engine. In this device heated air was injected or drawn into the steam pipe by specially designed nozzles and receiving cones ; consequently the mixture reached the engine at a reduced pressure, about one-third of the boiler pressure. The tests reported did not include data on fuel consumption ; hence no really convincing tests results were presented ; furthermore, it is difficult to conceive any increase in efficiency or economy by using such a method.

Nineteen years later there appeared in THE ENGINEER for June 25th, 1886, a statement concerning experiments on Parker's engine which extended over a period of two days. During the first day tests were made with steam used as the medium and on the second day with air injected into the steam pipe. The consumption of fuel per horse-power hour was practically the same for all tests. A detailed report of those tests could not be found.

In 1885 experiments were made by Zeller and Hunt at the New York Navy Yard for the purpose of ascertaining how much economic gain, if any, resulted from the use of a mixture of saturated steam and of compressed air in a non-condensing engine, the air being at the pressure of the steam and containing the heat of compression. The air cylinder and the steam cylinder were in tandem. Compression of the air started when the steam cylinder began to take steam ; consequently the air pressure was at its minimum when admission to the steam cylinder took place. Thus no air could enter the steam cylinder until the pressure of the air became greater than that of the steam when further increase in air pressure caused the exclusion of the steam. It is reasonable to conclude, therefore, that this engine was not operated by a *mixture* of steam and compressed air, but rather by steam and compressed air used *successively* and *separately*. Because of this fact the data secured from these experiments, which show practically no difference in power produced by using steam alone and by using steam and air combined, are not conclusive for intimately mixed air and steam.

Andrew Jamieson, at a meeting of the Institution of Engineers and Shipbuilders in Scotland, on April 30th, 1895, read a paper entitled "A New Departure in Steam Engine Economy, with a Description and Tests of Field's Combined Steam and Hot Air Engine." The tests of this engine showed a saving of 40 per cent. A hot air pipe was connected to the jacket and to each end of a single-cylinder non-condensing engine. The air was forced through a series of heating pipes in the main flue by means of a Roots blower which was driven by the engine. Admission of air took place automatically as soon as the exhaust steam began to escape, and continued until compression commenced late in the stroke. This hot air arrangement undoubtedly diminished or prevented cylinder condensation ; the results show a remarkably low steam consumption, 18.6 lb. per horse-power per hour for an engine of the type used. They also show only slightly higher consumption, 21.4 lb., at low load. The results expressed in terms of brake horse power, 24.26 at normal load, and 37.9 at quarter load, are not so striking probably because of the inefficiency of the engine and of the blower.

A recent attempt to produce an air-steam engine was made by E. J. Christy, of Waterloo, Iowa. The engine, rated at 300 horse-power, was constructed by the Vilter Manufacturing Company, of Milwaukee, Wisconsin. A five-hour economy test was reported, in which the steam used per hour was 26.35 lb. per horse-power at an average of 66.6 horse-power. Christy used a scheme of operating the engine on a four-stroke cycle principle, the first two strokes before admitting steam being occupied with taking in and compressing a charge of cold air. The heat of compression of the air produced a high temperature within the cylinder and thereby prevented initial condensation of the steam. It is very evident that the air itself performs no useful work ; therefore it is doubtful if any gain in economy resulting from mixing would more than compensate for the increased power loss of the two additional idle strokes. Furthermore, an engine operated on the principle of the Christy engine would necessarily have to be much larger for a given power and speed than one using steam alone, not only because of the two idle strokes, but also because of the smaller weight of steam that can be used when the clearance space is full of air.

An engine working on the same principle as the Christy engine was patented by G. Schimming in Germany several years prior to the announcement by Christy. The patent was acquired by the Actien-Gesellschaft für Eisengiesserei und Maschinenfabrication, formerly J. T. Freund and Co., of Charlottenburg, and an engine was built and tested in 1886 or 1887. No data of tests made on this engine are available, but it is stated that it proved a failure because of the enormous steam consumption and the large amount of water exhausted with the steam and air mixture.

An interesting but indirect application of the use of air and steam together is found in a hoisting engine for handling the skip in a single shaft 3700ft. deep at the Franklin Junior Copper Mine at Boston, Michigan. This engine was conceived by R. M. Edwards, general manager of the Franklin Mining Company, and was built by the Nordberg Manufacturing Company. The air cylinders, 36in. in diameter, are in tandem with the steam cylinders, 46in. in diameter, the stroke being 72in. The valve controls are arranged to make the air cylinders inoperative during the hoisting period and to make the steam cylinders ineffective during the return of the skip. The degree of compression in the air cylinders regulated by the operator controls the speed of the descending skip. There are three large receivers in which all the air compressed by the machine is mixed with the steam from the boilers. The mixture is then used in the steam cylinders during the hoisting period. A reducing valve in the steam supply pipe maintains about 65 lb. pressure on the receivers. During the fall of the skip the pressure in the receivers increases to approximately 95 lb. by the addition of compressed air, which is sufficient to lift the hoist about 1000ft. Steam alone, at a pressure of 65 lb., then completes the hoisting period.

* See THE ENGINEER, November–December, 1872, and October, 1873.

A THORNYCROFT MOTOR YACHT.

THE motor yacht Llys Helig, which has just been completed at the Southampton yard of John I. Thornycroft and Co., Limited, is an interesting example of a yacht specially built for all-the-year-round service. The vessel has been designed to embody the comfort of a yacht with the sea-keeping qualities of a strongly built ocean-going ship, and the firm's large experience of fast boats for naval and cross-Channel services has been drawn upon in evolving "lines" which give the best speed with the provision of adequate stability. The principal dimensions of the Llys Helig are :—Overall length, 107ft. 6in.; breadth, 19ft.; depth, 11ft. 2in.; and draught, 7ft. 4½in. In order to prevent the vessel from shipping water in a seaway an exceptional sheer forward has been given—13ft. freeboard at stem, 7ft. 6in. amidships to the top of the bulwark rail to 6ft. 6in. aft—combined with a large flare. A large steel deck-house, 55ft. long, with a steel deck over, accommodates the owner's quarters, which are conveniently arranged and furnished, while the crew are provided for forward. The machinery installation comprises a twin set of 4 M 4 Kromhout hot bulb engines supplied by Perman and Co. Each engine has four cylinders $13^{9}/_{16}$in. diameter, with a piston stroke of $13^{13}/_{16}$in., and is designed to develop a nominal 180 brake horse-power at a speed of 300 revolutions per minute. The engine and the reversing gear is controlled from a common hand wheel, and each engine is complete with bilge and water circulating pumps. In order to reduce vibration it was decided that the main engine seatings should be electrically welded instead of riveted, and the result has proved most satisfactory, the vessel showing scarcely any sign of vibration no matter in what way the engines are run. The oil fuel is stored in a main tank of 3500 gallons capacity—sufficient to cross the

Atlantic—and this tank serves the two 130-gallon service tanks, while a 250-gallon tank supplies the lubricating oil service. The engine-room has been designed with a view to ready access and overhead runways are fitted. Double silencers of special design ensure a quiet exhaust. A 4-kilowatt Gardner lighting set with a battery provides for the ship lighting and also provides power for the small Reid motor windlass. On her speed trials in Stokes Bay, in not too favourable weather, a speed equivalent to 12¾ knots in calm weather was obtained, which is a very satisfactory performance considering the moderate engine power. A more recent run to the Isle of Wight and back in rough weather was made at 12.2 knots with the engines running at 285 revolutions per minute, and the behaviour of the vessel demonstrated her sea-going qualities, which included easy rolling and steady course-keeping. The Llys Helig will undoubtedly form a worthy addition to the British motor yacht fleet.

Australian Engineering Notes.

IT is announced that a start is to be made this year with the Burrinjuck hydro-electric scheme. Our readers will remember that the Burrinjuck dam was built for the dual purpose of providing water for irrigation and of developing hydro-electric power. With the completion of the scheme the whole aspect of a large portion of the south-west of New South Wales will be changed. A dozen towns over a wide area will be supplied with cheap light and power, and it is anticipated that important industries will be established in consequence. A report by the Electrical Engineering Branch states that competition is now keener, resulting in lower prices, making the position regarding the Burrinjuck scheme much more satisfactory than when tenders were previously called. Practically all the preliminary work in connection with the scheme has been completed, including the survey of the transmission lines. The following are the chief towns concerned in the scheme:—Jugiong, Cootamundra, Gundagai, Junee, Wagga, Harden, Murrumburrah, Young and Yass. The work will be carried out in stages, and there is no complete estimate of the whole scheme. The initial work will be the construction of the off-take tunnel from Burrinjuck to the power house, and the foundations of the power house. Tenders will be invited for this work, and separate tenders for the turbines, switchgear, transformers, &c.

* * * * * *

THE South Australian Government has, it is reported, received from an engineering expert a report in which a scheme is set out providing for a central power plant at Cobdogla, to provide electric power for all the Murray settlements between Cadell, which is not far above Morgan, and Chaffey near the eastern boundary of the State. In this way 170 miles of the river could be served, and power could be supplied to Cadell, Holder, Waikerie, Kingston-on-Murray, Moorook, Cobdogla, Weigall, Loveday, McIntosh, Barmera, Berri, Chaffey and Spring-Cart Gulley. The proposal is that a distillation plant be installed at Cobdogla for the purpose of extracting alcohol and other chemicals from wood fuel, which is abundant in the district. The alcohol would provide motive power for the generating engines and the by-products would be sold. In this way it is estimated that a saving of £20,000 could be made. At present each settlement has its own pumping plant, mainly driven by producer-gas engines. Lately the cost of gas plants has been so high that several steam engines have been installed. The fuel consumption is a little larger, but there has been a saving of interest on capital cost. The Adelaide Electric Supply Company is also going into the question of supplying electric power from its Osborne works, or, in the event of the Moorlands lignite deposit turning out a payable proposition, a power station may be installed at Moorlands. The distance from Osborne to Cobdogla in a direct line is about 100 miles, and from Moorlands to Cobdogla about 80 miles.

* * * * * *

THE Commonwealth House of Representatives has passed the South Australian Farmers' Agreement Bill, which ratifies an agreement between South Australian Farmers' Bulk Grain Co-operative Company and the Commonwealth and South Australian Governments. It is proposed by the company to erect grain silos estimated to cost £1,500,000, to which the Federal Government will contribute £1,000,000.

* * * * * *

DURING the debate in the New South Wales House of Assembly on the North Shore (Sydney Harbour) Bridge Bill, the Minister of Works said that everything possible would be done to ensure that only Australian steel and Australian labour were used in the construction of the bridge. It is stated by the Sydney *Daily Telegraph* that the Bill is to be amended to provide that tenders may be submitted for an arch bridge instead of a cantilever structure. A Sydney engineer is already advancing claims for the arch type. Whatever decision is reached it is not expected that the bridge will be open for traffic for eight years.

* * * * * *

A WATER Supply Loans Application Bill, circulated in the Victorian Parliament, authorises the treasurer to issue and supply up to £1,693,000 for irrigation, water supply, drainage, &c. The main allocations include £275,000 for the Sugarloaf Reservoir, and £332,000 for operations under the River Murray Waters Acts. The Murray River works are estimated to cost Victoria, South Australia, New South Wales and the Commonwealth £8,000,000. A sum of £1,450,000 has already been expended on the river locking project, and during the next five years further locks will be constructed, one being under construction by both Victoria and New South Wales at the same time. It is hoped to construct the Hume Reservoir, near Albury, by 1929, at a cost of £1,600,000.

* * * * * *

THE Federal Public Works Committee has recommended the early erection of a new telephone exchange, and the installation of automatic equipment, at Sydney. The exchange will be known as City South. It is proposed to install an automatic switching system, having an immediate equipment for 8000 subscribers' lines and an ultimate capacity of approximately 16,000 lines. The specifications provide for a building of not less than six storeys of reinforced concrete. The estimated cost, covering the whole scheme, is £404,242.

* * * * * *

WE understand that the building of the City Railway, Sydney, is progressing satisfactorily. The first station platform, namely, that at Hyde Park, has now been constructed. Two sets of rails will pass through this station, and trains will follow each other at short intervals. The passengers will be taken from the platforms to the station exits in lifts, as on the London tube railways.

* * * * * *

THE Victorian Electricity Commission is proposing to install a complete pneumatic vacuum ash and dust extraction plant at the State brown coal mines at Yallourn, near Morwell. The extraction plant is to include two main low-level ash and dust suction pipes, and two subsidiary high-level dust suction pipes. Each unit is to be capable of dealing with heated ash and dust from brown coal at the rate of 6 tons per hour.

* * * * * *

PLANS for the supply of electric power from Yallourn to the larger centres of population in Gippsland have been submitted to the State Ministry by the Electricity Commission. The estimated capital cost is £112,150, and the annual cost of operating £18,012. If authorised this year the project can, it is anticipated, be brought into operation in two years. The starting point of the proposed extensions will be the State Government's high-power generating station at Yallourn (Morwell). The works provided for include a transmission line 90 miles long, *viâ* Traralgon, Sale, Maffra, and Stratford, to Bairnsdale, the estimated cost, including sub-stations, to be £77,720; a transmission line 49 miles long *viâ* Mirboo and Leongatha to Korrumburra, the estimated cost to be £32,300; and a transmission line 6 miles long to Moe, to cost £2130. This makes the total capital cost £112,150. It is pointed out that this is for the complete system of high-tension transmission only, and it does not include the cost of low-tension distribution in townships nor interest during construction. The annual cost of operation—£18,012—covers purchase of energy at Yallourn, capital charges (interest, sinking fund and depreciation), and all operating, patrolling and administrative charges.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ERRORS IN GAUGING.

SIR,—I have read with great interest the letters of Colonel R. E. Crompton, Mr. Hedley J. Thomson, Mr. T. W. Cooper, and Mr. William Taylor, in reply to mine of the week before.

Colonel Crompton's experience at the Birmingham Small Arms Company supports in every way the difficulties which I enumerated. It is interesting to notice that a special machine was designed in order to give accurate transference of size, and since no accurate standards were available, such as slip gauges, the difficulties were greater than they are to-day.

Mr. Hedley Thomson misunderstands my letter. If he will read it again it will be apparent that the difficulties I laid down were subject to the condition that the gauges were made by the firm themselves. Obviously, if the gauges are made correctly in the first place it is quite possible for a firm to work to Newall Class "A" tolerances; but the fact I wish to drive home is this, that the majority of firms make their own plug gauges, thinking that thereby they save money, whereas in reality they either considerably decrease the available tolerance in the shop or otherwise work to far larger limits than they think, so that either a firm should buy their gauges from reputable makers who have accurate means of standardisation available, or otherwise their tool-room must be equipped with means which will give them accurate standardisation.

I cannot agree that using slip gauges as standards for setting micrometers enables gauges to be made which, using ordinary commercial methods, pass holes within Newall Class "A" tolerances. Mr. Hedley Thomson says that he had no difficulty, when using such methods for checking, in obtaining this result; but I would like to point out that errors of standardisation are not apparent, *i.e.*, errors of standardisation can only be measured by having a means of measurement which is far more accurate than the means which produces the error. If micrometer measurement produces an error of standardisation of ± .00005, no person equipped with a micrometer could detect this, so I am afraid Mr. Hedley Thomson thinks that because his errors of standardisation were not apparent they did not exist.

With regard to measuring machines, I know that the average measuring machines available to-day do not give an accuracy of reading which is worthy of the accuracy to which standards can be purchased. The scale is obsolete; it cannot be produced to anything like the accuracy of that of end standards; it entails microscope readings which immediately makes the results largely dependent upon the personal element of the measurer; the magnification available is necessarily low, due to loss of illumination and loss of field due to vibration. When highly magnified, the graduated lines appear rather wide and rather difficult to centralise. Also temperature has a very large effect, since it is not always possible to use the same free length of scale as the size of the article being measured. When it comes to the examination of the elements of screw gauges the machine suffers still more, since here a very low microscopic magnification is all that is available.

In short, the machines do not give the results that are required, *i.e.*, a rapid and accurate measurement of length, diameters (both internal and external), screwed and plain, and the elements of threaded work such as pitch, &c.

It is obvious that the slip gauges are not the cause of the degrees of accuracy being unattainable, but the means of transference. As to whether the missing connecting link contemplated is my own measuring machine, I should like to say that I should be happy to describe anybody's measuring machine as that, provided it filled the bill properly. My main object in writing the letter was first of all to make the average firm realise what happens when they make their own gauges, and also, if possible, to point out to those makers of measuring machines which, according to Mr. Hedley Thomson, are in common use to-day, that from the practical man's point of view, *i.e.*, the attainment of the maximum accuracy at the minimum of cost, there is room for a great deal of improvement.

I feel that the principles of limit gauging are relatively so little understood that the more they can be aired the better it will be for the limit gauge system. The problem of unilateral and bilateral limits is a deep and exceedingly vexing one. There is no doubt but that the point raised, viz., that with the unilateral system the holes will be considerably above nominal, is true, and that, to commence with, this may entail the scrapping of plant. In the same way the unilateral system has a great deal to be said for it. It is extremely positive; that is, given a definite tolerance on the unilateral system the size is defined, whereas with the bilateral system the tolerance may be distributed in a thousand and one different ways. Mr. William Taylor, I think, put the matter in the clearest light when, during a discussion before the Institution of Mechanical Engineers, he stated that the difference between the unilateral system and the bilateral system seemed to him the same as between truth and falsehood—that there could be only one truth, whereas there could be any amount of falsehoods.

The B.E.S.A. have at the present moment, I believe, adopted a system which is a combination of the unilateral and bilateral, but I do not think that any recommendations have been made for either wear allowance, gauge errors and errors of standardisation. Until these are decided the limits are entirely unknown, since they will vary in every firm which makes its own gauges.

Mr. Cooper naturally feels hurt at my letter, which contained statements referring to the conditions in the general engineering industry, and not, I hope, applying so widely to people like ball bearing manufacturers. We naturally expect them to use something else than micrometers as a means of transferring size, but the conditions stated in my letter affect them indirectly in this way. There is no doubt but that the motor car industry is to-day faced with a comparatively large number of ball bearing failures, and these are not the fault of the bearing, but are entirely due to the methods of controlling the holes and shafts on and in which they fit. I have frequently seen a ball bearing forced into its housing by blows from a lead hammer, and this by large firms, the hole in the housing being too small because the firm have not allowed for wear in the "go" gauge, and also due to errors of standardisation. It is a great pity that such a fine product as a ball bearing should be utterly ruined by bad fitting caused by inferior control of the component parts with which they have to assemble.

I am afraid that I cannot conceive how it is possible with an accuracy of transference of size of ± .00002 to obtain a finished gauge which can be guaranteed within ± .00001; either something has gone wrong with Mr. Cooper's logic or his noughts. It is obvious that the errors in the finished gauge must be greater than the errors of standardisation alone.

The question of temperature is one which has covered a multitude of measuring machine faults. Whenever variations of reading are obtained on a measuring machine it is not the measuring machine which is at fault, but the temperature. I can assure Mr. Cooper that if a machine is employed which uses a standard of the same length as the size of gauge being measured, errors of temperature can be neglected. The variation of temperature due to work heating up during process of manufacture is, of course, in the case of work made to such fine limits as ball bearings, not negligible; but then this is a specialised business, and my letter was not intended to cover such a specialised business.

With regard to Mr. William Taylor's letter, I know only too well the struggle he has had to get the fundamental principles recognised which he laid down a large number of years ago. Mr. Taylor was thirty years ahead of the general engineering business and therefore obtained no support. Let us hope that ere long we shall see the principles which he laid down recognised and adopted by the users of limit gauges.

Coventry, December 22nd. AXEL C. WICKMAN.

THE HUMAN SIDE.

SIR,—"Timon," in his letter, bemoans that the human side seemed to appear in your journal as often as a blue moon. Anyone who compares THE ENGINEER with the daily Press can prove from hard facts that engineering journals contain as large a percentage of what is termed the "Golden Age." May I be permitted to quote part of a recent article in your esteemed journal. "The interest of the shareholders should not be the only, and certainly not the obsessing, concern of the directorate. Not many years ago the implied suggestion of a moral obligation to others than those who supplied the capital of an undertaking would have been deemed heresy. To many masters of the die-hard intransigent type, the old guard who learns nothing and forgets nothing. It may be said it is not sound finance to pay workmen-shareholders dividends out of employers' pockets, when they have not been forthcoming from any other source; but it must certainly be admitted to be very sound psychology, and such bread upon the waters creates the spirit of loyalty and devotion among the workers."

Alexander McLean refers that: "And these writers pretend to be surprised and pained at strikes, lock-outs, ca'canny, to say nothing of the more personal grievances that keep the staff from smiling." Since 1914 the opportunities for smiling have been few and far between, and to employ the words of Scotland's national poet, "Man's inhumanity to man makes countless thousands mourn." The cloud with the silver lining seems to be appearing; with it may the problem of the salvage of the social wreckage become a reality. May the same spirit prevail in the engineering industry as was within the little Edinburgh girl who was carrying a fat, lumpish, unprepossessing baby up one of the slippery streets. While staggering with the weight she was being watched by an old gentleman, who with sympathy remarked, "Why, lassie, that's a heavy burden (or ye." "Nae, sir," the child replied, "it isn't a burden; he's my brither."

In conclusion, may I repeat the words of the head of the largest engineering firm north of the Tweed, which appeared in a well-known welfare journal? "I sometimes feel that we should be more aggressive and less apologetic. How many thousands of workers and employers have been rendered more happy and, in consequence, more effective, as the result of the work of our staff. Their happiness and effectiveness are assets to the nation at large, and I hope that those who stand to gain by this will recognise their obligation towards us, and give us something more tangible than goodwill." ROBERT KEDDIE.

Eltham, December 26th.

A Seven-Day Journal.

The Prime Minister and Unemployment.

ON Saturday Mr. Bonar Law, as representative of the Central Division of Glasgow, received a deputation of his constituents in the matter of unemployment. The deputation urged that the proposed new highway between Glasgow and Edinburgh should be undertaken forthwith, that the Mid-Scotland Ship Canal should be begun, and that Scotland should receive a more generous share of the Government's assistance towards the electrification of railways. As also bearing on the unemployment situation, the deputation called for a reduction of working hours, the abolition of overtime, and the establishment of standard rates of maintenance allowance to the workless on the basis of 36s. per week for a married man and 30s. a week for single persons over eighteen years of age. The suggestion was made that the money required for providing the maintenance allowances should be obtained by reducing the interest on the war loan by one-half. In the course of his reply, Mr. Bonar Law uttered a warning that, under many of the relief schemes about which so much has recently been talked, work would not become available on anything like the contemplated scale until next winter at the earliest. The question of constructing the Mid-Scotland Ship Canal was, he remarked, being looked into by the Government, but his own opinion was that the Canal would never become commercially successful, and that as a naval security its merits were now so materially diminished that he could not recommend its construction. Dealing with the difficulty of increasing the unemployment grants, he illustrated the extent to which taxation is crushing industry by quoting figures supplied to him by the chairman of a large steel works. In 1914, according to this statement, local rates, direct charges and Imperial taxation other than income tax contributed 2s. 8.5d. to the cost of a ton of steel. In 1921 the same factors imposed a burden of 21s. 1d. per ton.

European Air Strengths.

THE present relative strengths of the air forces of this country, France and Belgium, now stationed in Europe, have been revealed in a written reply supplied by the Secretary for Air to Lieut.-Commander Kenworthy. It appears that while we have serving in Europe 15 squadrons of 12 machines each, France has 100 squadrons of 9 machines, and Belgium 14 of 10 machines each. Our total active service strength is 32 squadrons, as compared with 128 for France and 14 for Belgium. The *personnel* of the Royal Air Force serving in Europe includes 1158 trained pilots, 75 observers and 19,421 other ranks engaged on ground duties. France has made provision for maintaining in Europe 3039 flying officers and 30,477 other ranks. Information is not available as to how the first of these figures is divisible as between pilots and observers, while in the case of the second the figure excludes a large number of those engaged on ground duties who are obtained from the army. The Belgian total establishment is 2000 of all ranks, but reorganisation is now being undertaken. In the course of a reply to Major Attlee, the Minister stated that the number of machines on the French Civil Register on December 1st was 660, and that during the first eleven months of this year the French aircraft industry had produced 3300 machines for civil or military purposes, including those exported to foreign countries.

The British Empire Exhibition.

IN connection with his inquiry into the complaints made regarding the management of the British Empire Exhibition, Sir William Joynson-Hicks, Director of the Overseas Trade Department, has now held five meetings and has collected a mass of evidence from both sides. There is a considerable conflict of evidence, and it is proposed to resolve it by calling a meeting for January 2nd at which both the Exhibition authorities and those who have made complaints against the management will be present. Few of the general public, it is stated by Sir William, have expressed any desire to give evidence, and unless he receives additional names before January 1st, he will assume that there are no further complaints. The opinion of the Dominion High Commissioners is being sought as to whether the undertaking given by the Executive Council regarding the employment and supply of Empire products, to which we referred in the Journal last week, is satisfactory to them.

The New Battleships.

THE circumstances attending the placing of the contracts for the two new battleships continue to excite attention. At Glasgow, in the course of his reply to the representatives of the unemployed, the main points of which are summarised above, Mr. Bonar Law stated that the prices received from other quarters were "enormously lower" than those submitted from the Clyde, and that he was advised that the contracts would mean a big loss to those who built the ships. At Whitehaven the local Guardians have adopted a proposal that the Admiralty should be urged to stipulate that British iron ore alone should be used in the construction of the ships. It was stated that a million tons of iron ore would be required for the ships, and that the use of native material would provide employment for the whole of the West Cumberland ironstone miners. Replying to the criticism of the Glasgow Independent Labour Party regarding his remarks on the inefficiency of the Clyde shipyard workers, Lord Maclay stated that during the war the cost of merchant ships built on the Clyde for the Government was in most cases considerably higher than the price charged on the North-East Coast with identical specifications. A few months ago his own firm invited tenders for extensive repairs to a steamer. The Clyde figure was 20 per cent. higher than that quoted by East Coast shipbuilders. One of the Clyde tenders for the battleship hulls was, he said, £180,000 higher than that of shipbuilders elsewhere, and other Clyde figures showed, he understood, a still greater excess. It was the duty of the employers and the workers to explain this difference. If it were not due to shortage of output by the men, the public should be told its real cause.

The Slough Trading Company.

THE accounts of the Slough Trading Company for the eleven months ending on September 30th this year show a loss of £943,659. Deducting £129,882 brought forward and £221,856 which was placed in reserve in 1921, there thus remains a debit balance of £591,921 to carry forward. The company, it may be recalled, was registered in May, 1920, with an authorised capital of £820,000. For the ten months to October 31st, 1921, the accounts showed a profit of £651,738, of which sum £300,000 was capitalised, £221,856 was reserved to meet contingencies and £129,882 was carried forward.

Mr. Donald A. Matheson.

WE learn that Mr. Donald A. Matheson, general manager of the Caledonian Railway, has been appointed deputy general manager for Scotland of the London, Midland and Scottish Railway. He will thus have under his control the management of the Caledonian, the Glasgow and South-Western and the Highland railways. Mr. Matheson, it is gratifying to recall, is an engineer. After training in Edinburgh and Perth, he joined the engineering staff of the London and North-Western Railway, and ultimately rose to the position of chief assistant engineer for the Lancashire and Yorkshire district. Thereafter he went to Glasgow and was engaged as contractor's engineer on the construction of the Lanarkshire and Ayrshire Railway—a part of the Caledonian Railway. Later, he was appointed resident executive engineer in charge of the construction of the Caledonian Company's Glasgow Central Underground Railway. As the Caledonian Company's engineer-in-chief, he was responsible for carrying out the extension of the Glasgow Central Station, the widening of the bridge across the Clyde and other large works on the system. He became general manager of the railway in 1910, but has retained his connection with the engineering side by virtue of the fact that he holds the additional office of consulting engineer to the company. He is a member of the "Civils"—by the Council of which body he has been awarded a "James Watt" and a "George Stephenson" Medal—and a Past-vice-president of the Institution of Engineers and Shipbuilders in Scotland. During the war, he played a prominent part in the control of the railways, and in the supply to the western front of permanent way derived from existing railways at home.

British Aircraft Produced in America.

IT is on record, although the authenticity of the figures cannot be guaranteed, that in spite of the immense aeronautical programme undertaken by the United States during the war, not more than 700 American pilots saw service in France, and that of that number a considerable percentage was to be found outside the ranks of the American forces. Of the machines used by the Americans, only about 150 were produced on the other side of the Atlantic, the remainder being obtained from Great Britain and France. Given time, no doubt, the American Air Force in France would have risen to formidable strength, for, as is well known, the United States had an immense manufacturing programme in hand at the time of the Armistice. That programme, whatever may have been the case with the engines, involved the construction of a very large number of aeroplanes of British design, notably those of the de Havilland type. The position of these British designers with respect to royalties or other awards from the United States Government is now to be made the subject of a joint inquiry by the Royal Commission on Awards to Inventors and the American Commission for the Adjustment of Foreign Claims. It has been decided that no claim will be considered unless the applicant has before January 11th, 1923, signed an agreement referring the matter to the arbitration of the Joint Commission. Forms of this agreement and other information relating to the matter can, we are informed, be obtained from the Secretary (S.9.C.) to the Air Ministry. The subject is of interest to all those whose designs of aircraft, their engines and accessories were communicated to or were used by the United States during the war.

Statistics of the Iron and Steel Industries.

SINCE January, 1920, the National Federation of Iron and Steel Manufacturers has been issuing a monthly bulletin, giving figures for the production of iron and steel in Great Britain and in the other principal producing countries. An exceedingly valuable supplement to those bulletins has now appeared in the form of a small volume, in which are collected statistics relating to the iron and steel industries of the United Kingdom, the United States, France, Germany, Belgium, Luxembourg, Sweden, Italy, Spain, Canada and India. The figures given range back through a varying period of years, and cover a wide variety of factors. For instance, the ascertained prices of No. 3 Cleveland pig iron go back to 1879—the lowest, we notice, was 29s. 9½d. in 1886 and the highest 224s. 5½d. in 1920. Figures for the production of pig iron in the United Kingdom are given continuously back to 1839, and thence intermittently back to 1740—in which year the output was 17,350 tons, as compared with the maximum of 10,260,315 tons reached in 1913. Marked bar prices for Great Britain extend back to 1806—the figure then quoted, £17 10s. per ton, being higher than any subsequent price until January, 1919, when there began the upward rise which culminated in May, 1920, at £33 10s. In others of the tables the range covered does not exceed a few years, as, for instance, is the case for the production of iron ore in the United Kingdom by counties during the years 1913 to 1920—a table from which we learn that Yorkshire has held an easy lead in every one of these years, with never less than 3¾ million tons per annum. The figures given for the current production of this country are based, we notice, on the returns received from manufacturers responsible for 99 per cent. of our output. In every way, the volume is of great interest and value, and the Federation and its statistical officer, Mr. M. S. Birkett, are to be heartily congratulated on its production. It may be obtained, price 5s. 4d. post free, from the Federation's offices at Caxton House, S.W. 1.

A Mysterious Explosion.

ON the 14th inst. an explosion occurred at the Beckton Gasworks of the Gas Light and Coke Company while tests were being carried out on a new turbo-blower for pumping gas. The blower was being run light at the time, with the gas valves shut, in order to test the action of the governor and to examine its freedom or otherwise from vibration. As a result of the explosion, nineteen men had to be removed to hospital. Subsequently one of them died, but at the inquest on Wednesday, the medical evidence revealed the fact that death was not due primarily to the accident, although it might have hastened it. The cause of the explosion is not definitely known. Mr. Leach, the gas company's engineer, stated at the inquest that in his opinion an explosive mixture must have been present in the blower, and that it became ignited by some unknown means. The machine, he said, showed signs of heating, but it was impossible to say whether such heating had occurred before or after the blower left the manufacturers' works at Ipswich.

The World's Oil Burning Steamers.

FROM returns recently compiled by the United States Department of Commerce, it would appear that in the matter of the number and the gross tonnage of vessels over 500 tons fitted for burning oil under their boilers the United States takes an easy first place with 1790 ships having a total gross tonnage of 8,857,087. Many of those steamers represent the output of the American yards during and after the war, and it is therefore certain that although they may be classed as fitted for oil burning, the number would have been considerably reduced if the classification had taken account only of those oil-burning steamers which are in actual use to-day. Great Britain is second on the list with 601 ships of 3,460,428 gross tons, and Norway third with 175 ships and 668,819 tons. Then follow in order Holland, France, Japan, Italy, Denmark and Sweden. Germany occupies tenth place with only 30 steamers of 108,967 gross tons. All told, according to the Department of Commerce, the total number of oil-burning steamers in the world is 3110 and the gross tonnage 15,004,548. It thus appears that the United States owns more than half the total both of the number and on the tonnage basis.

A Heavy-duty Vertical Spindle Surface Grinding Machine.

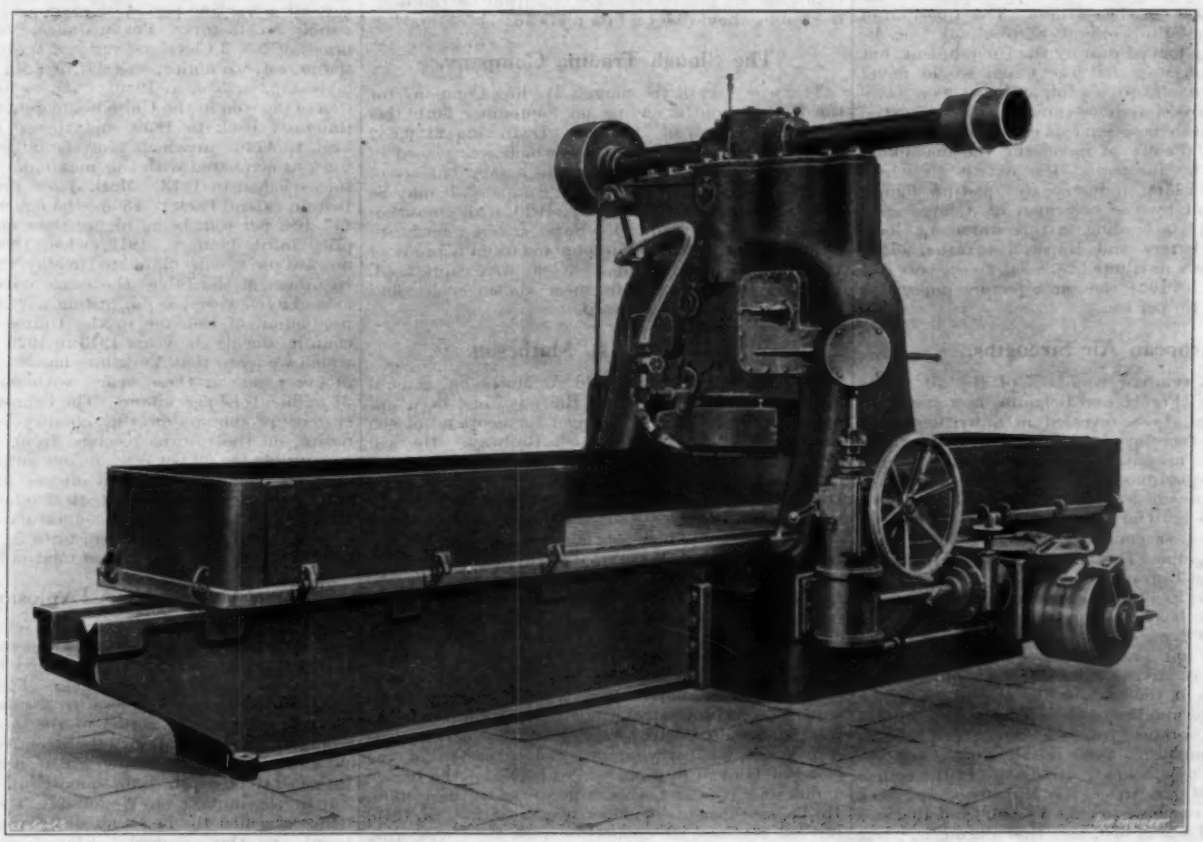
The machine illustrated herewith, the Lumsden No. 74 vertical spindle planer type surface grinding machine, has been designed expressly to meet the requirements of textile engineers in machining cast iron beams and rails of various sections and lengths. After several years of experimental research work in grinding, it has been proved, according to the makers, the Lumsden Machine Company, Limited, of Gateshead, that a cup wheel, built up of artificial abrasive segments, mounted in a suitably rigid machine and adequately supplied with power, is capable of removing metal at a rate hitherto unheard of in connection with grinding machines. Furthermore, the hard outer skin of metals commonly machined does not detrimentally affect the abrasive wheel, as is the case with planing and milling machine tools. Consequently, the machining allowances on patterns—in the case of castings—can be cut down to a minimum. The rapid removal of stock which is now attainable, taken in conjunction with this latter fact, makes it possible, it is claimed, to grind suitable flat surface work in a fraction of the time required for planing.

To meet the conditions set forth above, the Lumsden No. 74 machine has been designed and constructed on exceptionally rigid lines. The 30in. grinding wheel, consisting of a steel chuck, holding sixteen artificial abrasive segments, is mounted at the lower end of a heavy steel spindle. This spindle runs in ball and roller bearings, and is provided with a specially designed ball thrust. Spiral bevel gearing of specially treated high-grade steel provides the spindle drive. By this means disadvantages which are said to attach to the use of a direct-coupled motor or complicated belting have been avoided.

The balanced ram, in which the spindle is housed, has a vertical adjustment of 14in. to allow for varying heights of work. To this ram both automatic and hand feed can be applied, together with a rapid hand motion for bringing the wheel down to, and up from, its working position. The automatic feed has a range of from 1 to 60 thousandths of an inch per table stroke, advancing by thousandths. A massive casting bridging the table and securely bolted to the bed, provides a housing of extreme stiffness for the spindle ram. The bed is of a heavy box section with a continuous top web. The table is a strongly ribbed casting, bedded on V and flat ways. Its reciprocating motion is obtained by open and crossed belts, from a pulley connected to the main drive, thence by way of a four-speed gear-box to the rack through spiral gearing. The gear-box gives four table speeds, 6ft., 9ft., 13½ft. and 30ft. per minute, and is so designed that an instantaneous change can be made from any one of the three low speeds to the high speed.

The important question of the supply of water to the wheel and its collection has, it is claimed, been most carefully attended to. A large pump provides a heavy stream of water to both sides of the wheel, and wide troughs carry the return flow to an outer settling tank, from which the sludge can be readily removed. Hinged guards surrounding the table afford complete protection from spray to the operator. In the construction of the machine, dust-proof ball bearings have been provided throughout. Ease of operation and maintenance have been studied and given special consideration in every detail of the design.

The working surface of the table is 30in. by 15ft. long, and the approximate weight of the complete machine is 13½ tons. As for its performance, we are assured that it has removed metal at the rate of 23 cubic inches per minute. In our issue of November 10th we referred on page 497 to a reputedly American machine which was stated to have removed cast iron at this rate. We are glad to learn that the machine in question was not American, but the thorough British production illustrated below.



HEAVY-DUTY VERTICAL SPINDLE SURFACE GRINDING MACHINE

Brown Coals and Lignites.

In his third Cantor Lecture on this subject before the Royal Society of Arts, on Monday, December 11th, Professor W. A. Bone, F.R.S., dealt principally with the question of low temperature carbonisation of these coals and their use for steam-raising purposes.

He said that he did not advocate the low-temperature carbonisation of brown coals and lignites on the commercial side, because although great progress has been made in the low carbonisation of bituminous coals, the subject was as yet too much in the embryonic stage concerning brown coals to be regarded as of more than scientific interest. There were essential differences between the low-temperature carbonisation of these fuels as compared with bituminous coals, and he did not know of any large scale plant at work at present upon them in this respect. In fact, on the commercial and technical sides, the low-temperature carbonisation of these brown coals and lignites was comparatively new. Nevertheless, the study of their behaviour when they were heated to various temperatures was of great assistance in arriving at the chemical constitution of them as giving an indication of the products which were likely to be available when they were capable of being dealt with commercially, as would be the case in the near future. The objects to be aimed at in subjecting these coals to preliminary treatment by carbonisation was (1) to upgrade and stabilise their character as fuels; (2) to separate from the volatile decomposition any condensable oils and also ammonia, if it can be recovered in sufficient quantities to pay for its recovery; and (3) to utilise any surplus gas available. Of these objects one of the most important in the immediate future would be the first, viz., the upgrading of the fuels themselves. These coals were absolutely devoid of any coking properties, and their high percentage of oxygen gave them features which were quite different from the behaviour of bituminous coals at low temperatures.

Whilst he was not able to show illustrations of any low-temperature carbonisation plant in full scale working for this purpose, an apparatus had been constructed and was in use at South Kensington for testing fuels, and the results obtained with it very closely approximated to those which were found to be the case in practice as far as ordinary coals were concerned, and this apparatus, therefore, was useful in enabling conclusions to be drawn with regard to large scale work upon these brown coals and lignites. Working with this plant, certain results had been obtained with a dry brown coal containing 30 per cent. oxygen, when carbonising at 375 deg. Cent., 500 deg. Cent., 700 deg. Cent., and 850 deg. Cent. There was no evolution of any combustible gas up to 375 deg. except a very small quantity of carbon monoxide. At 500 deg. temperature, whilst there was also the evolution of carbon dioxide and water vapour, methane began to appear in the products, and at this temperature about two-thirds of the available oxygen was obtained in the form of oxides of carbon and steam. Passing up to 700 deg. temperature, the evolution of carbon dioxide fell off, but the evolution of methane had gone on rapidly increasing, and hydrogen also appeared, while at this temperature five-sixths of the oxygen came off as oxides of carbon and steam. Going to a temperature of 850 deg., there was a very large production of hydrogen, and these figures, obtained from a recent brown coal, were very instructive, as to the manner in which these coals carbonised at low temperatures.

On these lines, the following results were given of a dried Morwell coal, working at different temperatures, the figures representing proportions by weight :—

Temperature	500 deg. C.	700 deg. C.	850 deg. C.
Residue	67.6	53.3	50.9
Liquor	7.7	9.1	6.6
Oil and tar	3.5	8.3	3.3
Gas	19.4	26.6	35.6
Total	98.2	97.3	100.4

From these results, everything pointed to the fact that the gas formed at the higher temperature was at the expense of the oil.

A rather more matured lignite from Canada gave the following results :—

Temperature	500 deg. C.	700 deg. C.	850 deg. C.
Residue	69.7	62.0	60.2
Liquor	8.7	10.1	9.5
Oil and tar	2.5	2.9	1.8
Gas	20.3	25.2	29.3

Whilst a still more mature lignite from Burmah gave the following results on the same basis as in the two previous cases.

Temperature	500 deg. C.	700 deg. C.	850 deg. C.
Residue	70.7	60.0	59.0
Liquor	10.3	11.3	9.9
Oil and tar	3.0	3.8	2.2
Gas	15.5	24.9	29.1

These figures, said Professor Bone, showed the general features of the carbonisation of these coals so far as yields of different products were concerned, and they were compared with the ordinary figures of bituminous coals. A great deal of nonsense, continued Professor Bone, was talked as to brown coals and lignites being capable of producing very large amounts of valuable oils and tars having unheard-of properties and qualities. That must be taken with a considerable grain of salt, because so far as his investigations went, we must not expect from these lignites such high yields of tars and oils as were obtained from bituminous coals. He believed that the low-temperature carbonisation of these fuels would be largely from the point of view of improving the residual fuel. One fact brought out by the figures already given was that by going to a temperature of 850 deg. the whole of the oxygen was got rid of and a very good type of charcoal fuel was obtained, and he believed it would be from that point of view that the carbonisation of these fuels would be taken up. The likely yields of oils were shown from the following figures obtained from a good lignite carbonised at from 470 to 550 deg. Cent. :—

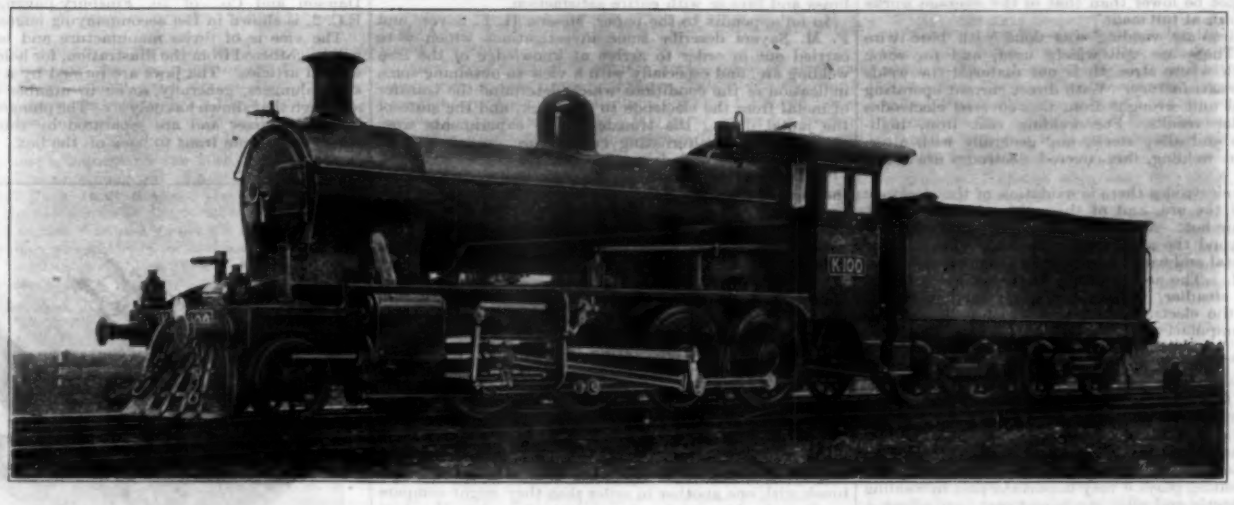
Oils.	Density.	Lb. per ton of coal.
Light spirits	0.85	13.8
Light oils	0.88	19.8
Intermediate oils	0.95	6.7
Heavy oils	1.0	22.5
Pitch	1.1	23.7

The residue from these experiments was such that in appearance it was difficult to distinguish between it and the original coal. The oils, for the most part, were of the napthene or hydrobenzene series, and there was very little of the paraffin hydrocarbons. When the higher fractions were cooled, a certain amount of waxy material was obtained which was hydrocarbon in character.

Passing to the question of what to do with the solid

VICTORIAN RAILWAYS—CONSOLIDATION TYPE LOCOMOTIVE

MR. A. E. SMITH, MELBOURNE, CHIEF MECHANICAL ENGINEER



residue from the carbonisation process, Professor Bone said that if it were mixed with about 5 per cent. of pitch, it made a valuable smokeless fuel, there being about 15 per cent. of volatile matter remaining, if the temperature of carbonisation was kept within the limits mentioned, viz., up to 550 deg. Cent., and if briquetted into a size of about walnuts, it formed an excellent fuel for use with chain grate water-tube boilers. The difficulty was that there was not sufficient pitch obtained from the process to provide the percentage required for briquetting, and one of the difficulties confronting the technologist in dealing with these brown coals and preparing them to rank as a good steam-raising fuel to stand transport, was to find a suitable substitute or substitutes for the pitch. The shortage of pitch and asphaltic residues, which had the same characteristics as pitch, was a very great hindrance to the development in this direction.

Another promising field of use for these coals was in a pulverised form for use in boilers, and experiments with Texas lignite in this form seemed to be of an encouraging nature. In using these coals as pulverised fuels, however, care must be taken to leave a certain amount of volatile matter in the residue after carbonisation, and apparently, from what one read of the work being done in America, 10 to 12 per cent. volatile matter was the proper amount. If the preliminary carbonisation was taken as high as 850 deg., there would be a risk of getting a residue which would not ignite rapidly enough to ensure continuous burning, because in a powdered fuel installation a great risk of explosion arose from a fuel which would not ignite rapidly enough to make the flame continuous.

Again, this residue formed a good fuel for gas-producer purposes, but even then it was advisable to briquette it before use. His experience was that there was no difficulty in gasifying either the raw lignite or the carbonised residue in gas producers, especially of the ammonia recovery type. The results of trials with French and Italian brown coal some years ago in a Mond gas plant showed 5.4 per cent. and 4.8 per cent. of methane, whilst in a later trial by himself with a Malayan lignite containing 20 per cent. of water, but with no ammonia recovery, he obtained 5 per cent. methane, and got a gas with a high calorific value. The actual yield of gas, of course, was much smaller than when using bituminous coal, but from 70,000 to 80,000 cubic feet of gas having a calorific value of 175 B.Th.U. gross was, in his opinion, a very good result having regard to the nature of the fuel that was being employed.

Finally, Professor Bone dealt with the use of these brown coals and lignites in their raw state for steam-raising purposes, because he believed that the immediate future of them would be determined by the manner in which they could be used for the generation of power on a larger scale. Consequently, it was necessary to find out the best conditions under which they could be prepared for steam-raising purposes. The great drawback hitherto had been that engineers had approached the problem from the point of view of utilising a new fuel in boilers of the ordinary construction, instead of re-designing the boiler and furnace for the special purpose for which it was to be used. The result had been that there was a tendency to condemn these fuels on the results of tests obtained in this way. This was an aspect of the problem in which chemists would have to play an important part, whereas hitherto it had been in the hands of the engineer, because as far as he could see, the engineer, if left alone, was likely to make a poor show of it. The first idea of the engineer was to shovel the coal in its raw state into a boiler furnace which had been designed for burning bituminous fuel. Experiments had been carried out in America for nearly twenty years on these lines, and the results, necessarily, were most unsatisfactory, and those who carried out the experiments came to some extraordinary conclusions as a result. The brown coals used contained in one case 52 per cent of water, and in another 32 per cent. of water, and the conclusion come to in one instance was that the moisture content of the lignite did not appear to affect the boiler efficiency materially. That was a remarkable conclusion, and if the consideration which he had been putting forward were to have any weight at all, it must be dismissed altogether. That conclusion was come to as the result of some Canadian trials, but his reply to that was that what did matter was the carbon-hydrogen ratio in the coal. Experiments carried out quite recently with Morwell coal at the Melbourne electricity works showed that fuel containing 44 to 46 per cent. of moisture—which he submitted it was very foolish to charge into boilers—generally gave an efficiency of 55 to 60 per cent. Later than that—in 1919—some American tests were made in which the problem was tackled scientifically, and a boiler was used in which the conditions of the furnace could be altered and modified as observations of the combustion of the coal developed. The moisture in the coal was reduced to from 15 to 20 per cent., and it was found necessary to design the furnace to give sufficient draught so that a high rate of combustion could be maintained. He had formed the conclusion, after making several boiler tests, that a satisfactory rate of combustion for a fuel of this kind was 40 lb. per hour per square foot of grate area, compared with a maximum of 30 lb. with bituminous coal. Therefore, they must have a combustion chamber large enough to ensure vigorous combustion of the very large amount of volatile hydrocarbons given off from the fuel.

The matter had been taken up from this point of view by Mr. W. R. Wood, of the Underfeed Stoker Company, and experiments were being carried out by the Electricity Commissioners at Morwell, Australia, with B. and W. boilers and Underfeed stokers, in which the plant had been so designed as to make use, in a kind of fuel improver, of the waste gases from the boilers for drying the Morwell coal before it reached the furnace. The coal was subjected to the heat of these waste gases from 30 to 40 minutes before reaching the furnace, and the results so far had been extremely promising. When the boilers were fired with the raw Morwell coal, 2997 lb. per hour were burned, the furnace temperature was 1700 deg. Fah., the water evaporated 6550 lb., and the gases leaving the boiler at 557 deg. contained 10.3 per cent. of carbon dioxide and 1.7 per cent. carbon monoxide. When fired with fuel that had been subjected to the preliminary drying treatment mentioned, it was possible to burn 8000 lb. of fuel per hour; the temperature of the furnace rose to 2100 deg. Fah., the water evaporated was 20,200 lb., the gases left the furnace at a temperature of 599 deg., and the carbon dioxide had risen to 13.5 per cent., and the carbon monoxide fell to 0.33 per cent. Thus the gas had been reduced considerably in temperature. If this experiment proved to be a practicable one after prolonged trial, it would be realised what an enormous capital saving could be effected, at the same time doubling the capacity of the boilers almost. The contract for the twelve boilers for the power station using Morwell coal in Australia came to something like £300,000. If by any means it was possible to double the capacity of these boilers it was seen at once what an enormous capital saving could be effected. Whether this particular solution of the problem proved to be the right one or not, the point he wished to urge most strongly was that the problem should not be left to the engineer alone.

THE BRITISH CAST IRON RESEARCH ASSOCIATION.

THE new director of research of the British Cast Iron Research Association (Dr. P. Longmuir), since beginning his work, has been taking stock of the position of the principal researches in hand and formulating a scheme for advancing them as rapidly as possible.

Cast Iron Moulds for Making Glass Bottles.—The director has arranged a scheme of research upon these moulds, and special castings will be made at once for the purpose of practical works tests. There is a very wide field here to give members a new trade opening. A large number of these moulds are imported from abroad. They will, it is hoped, be now made in this country.

Magnetic Properties of Cast Iron.—Inquiries having been sent in to the Association upon this important matter, the director is taking steps to open an investigation into the subject.

High Silicon Cast Iron to Withstand Mineral Acids.—It has been pointed out to the Association that a research into this material is of very great importance to the cast iron industry and to allied trades. Some work has already been done by outside agencies without very great results being obtained. The Association will, therefore, take the matter up at once.

Standardisation of Testing Methods for Cast Iron.—The Special Committee appointed to investigate the standardisation of test bars is collecting a large amount of practical data and has received valuable help from the American Testing Society. A questionnaire has been issued and the replies are being tabulated. The conclusions of the Committee will be of great assistance in drawing up an international standard for testing.

Consolidation Locomotive for the Victorian Railways.

As a consequence of the desire of the Railway Commissioners of Victoria, Australia, to increase the power of the locomotives operating on light lines laid with 60 lb. rails, a new type of light "Consolidation" class locomotive has been designed for operating on new development lines having minimum curves of 8 chains radius with gradients of 1 in 30. Special attention has been paid in the design to the lightening of moving parts, and efforts have been made to obtain, consistent with the permissible weights on the wheels, the largest possible boiler capacity and grate area. Because of the limitation of the length by the existing turntables, it was necessary to adopt the "Consolidation" or 2–8–0 type rather than the "Mikado" 2–8–2 type, which, of course, limits the boiler capacity and grate area. As far as possible standard parts, such as tires, boiler fittings, axles, axle-boxes, &c., have been used to avoid the introduction of other standards, and the tenders are standard with those of other types of locomotives operating on the Victorian Railways. The first locomotive, of which we reproduce a photograph, has been delivered from the Government railway workshops at Newport and has been put to work with, we are informed, gratifying results.

The following are the principal dimensions :—

Type	2–8–0
Diameter of driving wheels	4ft. 6in.
Cylinders	20in. dia. by 26in. stroke
Tractive power	26,193 lb.
Boiler pressure	170 lb.
Heating surface—	
Fire-box	125 square feet
Tubes	1313 square feet
Superheater	303 square feet
Total	1741 square feet
Grate area	25.75 square feet
Tender capacity—	
Water	4300 gallons
Fuel	5 tons
Total length overall, engine and tender	59ft. 4½in.
Total weight, approximate—	
Empty	83 tons 10 cwt.
In working order	103 tons 10 cwt.
Haulage capacity	378 tons on 1 in 50 gradient

Electric Welding Apparatus and Equipment.

ON Thursday, December 14th, Mr. J. Caldwell read a paper before the Institution of Electrical Engineers on "Electric Arc Welding Apparatus and Equipment." The physical features of the iron arc, as used for welding ferrous metals, were considered, and the various types of apparatus and equipment which have been developed for welding work, were described. The following is a brief abstract of the paper :—

Good welding can be done with both direct and alternating current. There are preferences, and as direct current had the start more operators and others were in favour of direct current than of alternating current. The best electrical conditions are slightly different, and there are differences in the actual manipulation, but experience shows that operators who have been accustomed to one readily adapt themselves to the other. It is also the case that flux-covered electrodes are essential for alternating current, apparently because the lagging effect of the flux and slag maintains the necessary temperature during the periodical current reversals. The only real difference is that the striking of the arc is rather more difficult with alternating current.

A higher open-circuit voltage is required with alternating current. With direct current an arc can be maintained with a minimum of 45 volts—open circuit—but 60 volts is much easier to work with, and can be taken as the practical figure. A higher voltage permits of an excessive arc length and a poor quality of deposit.

With alternating current the open-circuit voltage should be from 75 to 90 volts. The difference between the arc voltage and the open-circuit voltage has, in the case of direct current, to be taken up in a steadying resistance, while a reactance is used with alternating current.

There is, therefore, not so much difference in the steadying losses as might be supposed. It may, indeed, be possible to make alternating current more efficient in this respect than direct current. The alternating-current arc has a lagging power factor, but the magnitude of this depends a good deal upon the steadying and regulating equipment, and it need not be lower than that of the average works induction motor at full load.

The first iron-arc welding was done with bare wire electrodes. These are still widely used, and for some kinds of work where strength is not material the welds made may be satisfactory. With direct current operating on mild steel and wrought iron, flux-covered electrodes provide better results. For welding cast iron, high-carbon steels and alloy steels, and generally with alternating-current welding, flux-covered electrodes are necessary.

With bare electrodes there is oxidation of the electrode itself beyond the arc, and of the weld metal and work whilst they are hot. A suitable flux covering protects the electrode beyond the arc, forms a protective slag on the deposited metal and work, and reduces the access of air to the arc itself. The arc length is somewhat greater and the current steadier, probably because the current is confined to the electrode end, and it cannot reach the outside. Manipulation is easier, as the arc can be struck on hot slag without any liability of the electrode to "freeze on." The deposit from a covered electrode on to a flat surface spreads more than that from a bare electrode, owing to the fluxing action of the slag, thus making a wider union and a neater finish. Coated electrodes are essential for use with alternating current, probably because the coating and slag conserve the temperature during the periodic variations of the current.

The flux coating plays a very important part in welding high-carbon steels and alloy steels and cast iron, where it is necessary to obtain weld metal approximating in composition and structure to those materials. The electrode metal passing through the arc is considerably altered in composition; for example, carbon and manganese are burnt, or rather oxidised, by the reducing influence of the arc. The flux coating reduces the amount of this change, and may impart or restore the desired constituents. Whether this action takes place in the arc, or between the flux and the deposited metal, or partly in each, cannot be said. In the manufacture of steel the reactions between the metal and the flux in the furnace are essential parts of the process, and the composition of the flux is carefully adapted to the product desired. In arc welding, however, the time available for reaction is very short. The short time, the high temperature and the fine division of the electrode metal passing through the arc, are conditions widely different from those of the steel furnace, and a great deal of experiment has consequently been needed to arrive at the proper fluxes for different materials. In matching any particular steel the composition of the electrode and the flux co-operate. The electrode metal does not, as a rule, match that of the material. The work of producing electrode and flux combinations which will make good welds in different materials has met with great success. It has necessarily been done empirically, as no general principles can yet be formulated. In the result, cast iron, manganese steel, nickel steel, stainless steel and other special alloy steels are all successfully arc welded by the use of appropriate electrodes and fluxes.

For most purposes a flux coating of a basic nature is desirable, but in some cases it is of an acid description. An aluminium wire or tape is sometimes included, and nickel plating is also used. Both these metallic additions tend, in different ways, to reduce oxidation of the electrode metal, and may also have other effects.

Intermediate between bare and coated electrodes are dipped electrodes, *i.e.*, electrodes dipped into a "slurry" of a basic nature. This coating has some protective influence on the electrode as against oxidation, and reduces spluttering and current fluctuations as compared with bare electrodes. It is not a substitute for flux coating.

The current required for welding depends mainly upon the thickness and mass of the parts to be joined. It may be said with certain qualifications, that the dimensions of the work determine the current, and the current determines the size of the electrode. For each gauge of electrode there is some maximum manageable current. If this maximum is exceeded the electrode fuses far beyond the arc, large portions drop, the current fluctuations are wild and the arc is turbulent and unmanageable. For coated electrodes the maximum currents range from 60 ampères for No. 14 gauge to 200 ampères for No. 4 gauge. The current densities thus vary from about 12,000 ampères per square inch for the smaller, down to about 5000 ampères per square inch for the larger. Somewhat higher current densities can be used with bare electrodes. The American practice, which is chiefly with bare electrodes, is to use 10,000 to 12,000 ampères per square inch.

Mr. H. M. Hobart, who has taken a leading part in electric arc-welding development and research in the United States, says that the largest current which can be used, makes the soundest welds. Too large a current for the thickness and mass of the work burns holes in it.

Welding thin sheet is practicable but has not been much developed, possibly because oxy-acetylene and resistance welding have a firm hold on this class of work. Recent experiments, however, promise good results, and thin sheet arc welding may prove commercially valuable.

As the result of recent research work, four types of electrodes are now available for the purpose of welding and depositing non-ferrous metals. The perfection of these products to a commercial stage represents the latest development in the successful application of electric arc welding for construction and repair. The metal core is of tinned copper, surrounded by a flux covering, which adheres firmly to the welding rod and does not break away when subjected to transport and workshop usage. This flux covering is of special composition to suit the nature of the copper alloy to be welded, and produces a powerful reducing atmosphere around the work to ensure the deposition of good metal in the weld. Copper and the various alloys of brass and bronze in general use have a very short temperature range between the welding and fusion points, and practice is necessary to prevent the metal becoming fluid or remaining in a sluggish condition. Care must be taken to prevent the parts being welded from being pierced by excessive heating. It is not necessary or advisable to hammer the metal deposited, as this is perfectly homogenous and free from blow holes. The electric current requires to be regulated according to the nature and dimensions of the material to be welded. Once this has been ascertained, however, the welding operation should be proceeded with as rapidly as possible, when no difficulty will be experienced in welding copper, brass and bronze with entire satisfaction.

In an appendix to the paper, Messrs. H. F. Sayers and F. M. Sayers describe some investigations which were carried out in order to arrive at knowledge of the iron welding arc, and especially with a view to obtaining some indication of the conditions which determine the transfer of metal from the electrode to the work, and the state of the metal during the transfer. The experiments were confined to the alternating current arc operating at a frequency of 50 periods per second.

In opening the discussion, Mrs. Ayrton remarked that she noticed that there was no mention in the paper of a back E.M.F. in the arc. She had shown that there was no back E.M.F., but only a resistance offered by the vapour. In welding work it was desirable that the metal should go deeply into the work. That was why a short arc was essential, for a short arc always gave a deep crater. With an alternating current arc the whole of the metal was in a highly vaporised state, and was deposited more quickly than it was with direct current. The ideal arc for welding was the alternating current arc.

Mr. H. M. Hobart, who has been prominently connected with electric welding in America, referred to the fact that whilst in this country flux-covered electrodes are used on an extensive scale, 95 per cent. of the welding is done in America with bare electrodes. That, he thought, was a rather remarkable fact, and it seemed to indicate that English and American engineers should keep in closer touch with one another in order that they might compare results. In his opinion bare electrodes gave the best results when used by men accustomed to using them. Nevertheless, the difference between English and American practice seemed to indicate that either English or American engineers were making a mistake, and it would be interesting, he thought, to ascertain which of the two was at fault.

Dr. Clayton H. Sharp also referred to the difference in English and American practice, and the need for closer co-operation between the engineers of the two countries.

Mr. C. R. Darling did not think that engineers had made very much progress in the direction of understanding the nature of the iron arc. It was a good deal cheaper to use bare electrodes than flux-covered electrodes, and it ought not to be a difficult matter to discover which type of electrode gave the best results. Personally, he believed that flux-covered electrodes often contained a lot of unnecessary stuff.

Captain W. R. J. Wallis Jones opened his remarks by referring to the progress which arc welding made during the war. He thought that it was almost correct to say that during that period arc welding had been re-invented. The author had referred to the possibility of operators of alternating current equipments receiving shocks, but he doubted if the full significance of that statement was recognised. A Government report, which was issued some time ago, showed that there had been no fewer than ninety-eight fatal accidents in six years. Fortunately, however, devices had been invented which made it impossible for operators of alternating welding equipments to be injured. Finally, the speaker referred to the arc-welding machines which had been developed in America, and remarked that one of those endless electrode machines was capable of operating continuously for sixteen hours.

Mr. W. L. McClelland referred to the useful work which the author did during the war in the direction of teaching men to use arc welding equipments. During the war, he said, electric arc welding was of immense value. In one case a ship which had been badly damaged, and which was brought into one of the naval dockyards, had to be repaired in the shortest possible time. In the ordinary way the repairs could not have been carried out in less than two or three months, but with the aid of electric welding it became possible to do all the work necessary in between two and three weeks. Alternating current arc welding offered few advantages, and his experience showed that the welds made with alternating current were not so good as those made with direct current. The latter welds had more uniform strength. Many special direct-current generators had been designed for welding work, but his experience had shown that all a skilled operator needed was a flat compound generator working at a pressure of from 70 to 80 volts.

Mr. E. B. Wedmore referred to the necessity for further research. Judging from the large amount of important repair work which the author had referred to and illustrated on the screen, there should be no lack of funds for work of that kind. The Electrical Research Association would be pleased to co-operate in that work.

Mr. H. M. Sayers exhibited some interesting oscillograms of the voltage across the arc, the supply voltage and the arc current. In referring to the remarks of Mr. Hobart, Mr. Sayers said that it was to be remembered that in America alternating current arc welding was not practised to the same extent as it was in this country, and that might possibly account for the fact that bare electrodes were used more extensively in the United States.

In his reply, the author referred to what Mr. Hobart and Dr. Sharp had said about the use of bare electrodes, and said that he hoped they would remain in this country until they had witnessed some tests. The chief advocate of bare electrodes, he noticed, had not taken part in the discussion. Although the Americans had used arc welding more extensively than English engineers, the welding work that was done in the United States did not equal that which was done here. Welding machines, such as those referred to by one speaker, were limited to repetition work, and were not used in this country.

NEW Statutory Rules and Orders have just been issued by the Secretary of State, concerning the fencing and general protection of wood-working machines. The regulations are numbered 1922, No. 1196, and may be obtained at the Stationery Office, price 2d.

A New Vice.

A NEW form of a more or less familiar type of vice, which is being introduced into this country by Bruce, Dawson and Co., of 70, Finsbury-pavement, London, E.C. 2, is shown in the accompanying engraving.

The vice is of Swiss manufacture and is intended, as will be gathered from the illustration, for holding irregular-shaped articles. The jaws are formed by a series of hard steel plungers, generally seven in number on each side, although that shown has only six. The plungers are grouped in strong boxes and are separated by thin steel plates which reach from front to back of the box. Each plunger

SPRING PLUNGER VICE

also has a couple of helical springs at the back which bear against the end of the box. Both the boxes are provided with nuts and square-threaded screws for tightening them together, and have set screws in their sides for pinching the plungers and separating plates. In use the jaws are closed together until all the plungers have got a bearing on the article to be held, the pinching screws are then tightened up to hold the plungers and a final grip given to the jaws.

The arrangement of the plungers with the interleaved separating plates has the advantage that a large frictional surface is provided for resisting the gripping thrust of the jaws. The plates themselves cannot move back, as they all abut against the back of the jaw box and the pinching action of the set screw is transmitted right through the bunch of plungers and plates. Thus the plungers are held as tightly as if each one were separately gripped by a set screw. The whole vice is nicely made and the transverse movement of the plungers, when the set screw is tightened, is hardly perceptible. The one shown in the illustration is intended for bolting on to the face plate of a lathe, but several other designs are manufactured.

RUNNING AND OPERATING MARINE DIESEL ENGINES.

IN a paper read before the Institute of Marine Engineers on December 5th, Mr. A. J. Brown dealt with the running conditions and operating symptoms of marine Diesel engines. The author has had experience of the actual running of motor ships, and at the outset he emphasised the necessity of knowing the exact condition of each constituent part of the engine, and what service it is capable of before needing attention. Such knowledge, he said, might entail extra work at the beginning, but it undoubtedly reduced the amount of work to be done in the engine-room and lowered maintenance costs, while in the event of trouble occurring much time was saved by the elimination of unlikely causes and the seat of the trouble was more readily detected. The value of taking accurate indicator cards and readings throughout the voyage, and particularly at the beginning and end of any trip, was commented on, and it was shown that a careful study and comparison of the records would achieve much in revealing possible causes of trouble. The methods of valve and piston ring testing by means of compressed air are described, and the routine work necessary on the top, middle and control platforms is outlined. For engines with a top-level cam shaft the author expresses himself in favour of placing the control platform at the top of the engine, and he cites in support of this view the engine-room arrangement which is adopted in many of the modern single and double reduction geared turbine engine-rooms where the main control platform is raised to the turbine level, while the air, feed, and circulating pumps and auxiliary lighting sets are controlled from different levels. The subject of air compressors and their running and maintenance occupies a considerable section of the paper, as also does the equally important question of auxiliary engines. In the opinion of Mr. Brown, the trend in the design of auxiliary engines appears to be in the direction of a reduction of the speed at which they are run. This is a point, he says, that will be appreciated by marine engineers, for high-speed engines usually require frequent overhaul and adjustment of main and connecting-rod bushes, especially if attention is not given to the proper cleaning and filtering of the lubricating oil. The paper, which was illustrated by diagrams of the Beardmore-Tosi type of engine, closes with an appeal for organised routine in the care and maintenance of marine Diesel engine plant.

THE new plant which is being erected at Sydney, Nova Scotia, by the British Empire Steel Corporation, will double the firm's output of galvanised wire for fencing. The company will, in consequence, be able to turn out 120 tons of galvanised wire fencing per day.

Railway Matters.

AT the quarterly meeting of the Central Wages Board on the 20th instant it was agreed that as the cost of living figure on December 1st was the same as on September 1st, no change should be made in the railwaymen's wages on January 1st.

THE Spanish Ministro de Fomento has been authorised to invite tenders for the electrification of the Ripoll-Puigcerda railway, which runs across the Pyrenees. Inquiries may be addressed to Señor Ingeniero Jefe de la Segunda Division de Ferrocarriles, calle de Balmes 32 (2°), Barcelona.

AT the coroner's inquest on the 20th instant into the death of a passenger arising out of a collision on the 6th at Birkenhead Park Joint Station, the jury returned a verdict that the accident was due to an error of judgment by the driver of the Wirrall Company's train from West Kirby. This man passed the outer and inner home signals at "danger," and allowed his train to foul the crossover road through which an outgoing train was passing.

SEVERAL members of Parliament have been suggesting all sorts of schemes for railway extension with a view to finding work for the unemployed. One somewhat popular idea is an extension of the Great Northern, Piccadilly, and Brompton tube from its northern terminus at Finsbury Park. Such an extension would, no doubt, be useful, and may be advisable, but it means, as an important first preliminary, the purchase of private property, and not even Parliament can secure that without a certain procedure.

THE failure of a wagon coupling led to a division in a down goods train south of Crewe in the early hours of the 20th instant, and owing to the falling gradient the second portion caught up and ran into the first portion. Several wagons were derailed. This is a class of accident which continuous brakes for goods trains would avoid. Failures of couplings would still occur, but the separation would at once pull apart the brake couplings and the brakes automatically would go on in both portions and the whole train would be brought to a stand.

BEFORE the House of Commons was prorogued, Mr. J. H. Thomas asked a question as to locomotive failures, to which Colonel Ashley replied that the total number of engine failures reported to the Ministry of Transport during the first nine months of the year was not in excess of those of previous years. There had, however, been certain cases in which fractures of connecting-rods had led to serious results, and that matter was being carefully watched by the inspecting officers. He did not think that in all the circumstances there was any necessity to appoint a Select Committee as suggested by Mr. Thomas.

IT was officially announced on the 19th instant that terms had been arranged for the inclusion of the North Staffordshire in the London, Midland and Scottish Railway. In the Engineering Notes for November which appeared on page 569 of our issue of December 1st, we pointed out the excellent position in which the North Staffordshire stood. In 1913 it paid 5 per cent.; during the war the dividend fell to 4½ per cent.; but for the last four years the company has paid 5 per cent. On the basis of 5 per cent. for the North Stafford and 7½ for the London and North-Western, £100 of the former was worth £67 of the latter. If, as in 1913, the 7 per cent. of the North-Western were taken, it would give £70. The North Staffordshire has, however, got £74 for each £100 of ordinary stock. The Caledonian, apparently, still holds out.

THE suitable names for the groups of railways have long been canvassed, and it cannot be said that anyone is satisfied with those chosen for the two other than the Great Western and the Southern. The North-Western, Midland and West Scottish, in choosing "London, Midland and Scottish," is, as the Railway Amalgamation Tribunal chairman observed on the 19th, annexing the whole of Scotland, and Sir William Acworth has pointed out that the "London and North-Eastern Railway" means five letters for its initials. What we would observe on the matter is that under the abbreviations that come to all long names the former will soon generally have its prefix and suffix dropped and be known as "The Midland," whereby the North-Western will entirely lose its identity, and the latter will come to be called "The North-Eastern."

IN this column, during the year 1918, there were several references to the Midland Company having closed an auxiliary entrance in Station-street to its Nottingham station. Before the present station was built the main entrance was in that street, but for the new station it was in Carrington-street, which is a main street into the town. A minor entrance was, however, retained in Station-street, and suited the convenience of people coming from the south-east. When, under war conditions, Nottingham was made a "closed" station, this entrance was shut up. Many questions were asked about it in Parliament, and Colonel Pringle visited the place, but nothing was done. Recently the Nottingham Corporation applied to the Railway and Canal Commission for an Order, but when it was shown that the reopening would cost the railway company £200 to £300 a year, and that it would save only 16 per cent. of the passengers walking an extra 85 to 200 yards, the Order was refused.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first ten months of the present year was as follows, the corresponding figures for 1921 and 1920 being added in brackets:—Locomotives, £4,287,033 (£6,594,903, £4,407,201); rails, £2,097,561 (£2,429,468, £2,144,720); carriages, £1,593,057 (£1,322,379, £1,411,838); wagons, £2,841,334 (£4,979,776, £4,752,725); wheels and axles, £1,032,056 (£1,456,632, £1,566,002); tires and axles, £356,777 (£1,107,752, £1,124,491); chairs and metal sleepers, £1,832,704 (£1,119,361, £1,019,459); miscellaneous permanent way, £1,184,275 (£2,242,652, £1,944,361); total permanent way, £6,657,196 (£8,581,597, £7,907,991). The weight of the rails exported was 210,166 tons (122,702 tons, 107,703 tons), and of the chairs and metal sleepers 128,282 tons (46,541 tons, 47,337 tons). Locomotives to the value of £322,280 were shipped during the month of October to European countries other than Spain, and of £151,766 to India. Rails to the value of £49,436 went to India and of £28,523 to South Africa.

Notes and Memoranda.

THE November output of pig iron in the United States amounted to 2,849,703 tons, which is the largest amount since November, 1920, and a gain of 11 per cent. over the October output. The production, which is at the yearly rate of 35,500,000 tons, is more than twice that of last year's output.

OUT of a total of 2,100,000 horse-power of electrical energy at present in use in France, 650,000 horse-power is for lighting, heating, and minor power; 1,300,000 horse-power for industrial use; 50,000 horse-power for traction purposes; and 100,000 horse-power for agricultural and other miscellaneous uses.

THE new hydro-electric plant on the Winnipeg River, Canada, which will be put partly into commission this winter, will ultimately include six units of 28,000 horse-power each for generating 11,000-volt current. The dam, 70ft. high by 4000ft. long will provide a working head of 56ft. The total cost is working out at 60 dols. per horse-power.

THE results of experiments in the cryogenic laboratory of the American Bureau of Mines lead Dr. Moore to believe that within the next decade 99.9 per cent. helium will be produced at a cost as low as 20 dols. per one thousand feet, and that the production cost will be reduced rapidly. Once helium is produced at a moderate cost, he expects to see the lighter-than-air ship take its place as one of the permanent agents of transportation.

THE difficulties of the Japanese shipbuilders are becoming more pronounced as business depression increases. At the end of 1920, for instance, forty-five vessels, with a total tonnage of 174,848, were in course of construction, but in June, 1922, only twenty-six, with an aggregate tonnage of 103,270, were on the stocks. Again, at the end of 1920 the number of workers employed by all the shipbuilding yards totalled 150,000, but the number is now reduced to 55,000.

THE great bucket dredger designed by the Magadi Soda Company for digging soda out of Lake Magadi, East Africa, was intended to have an output of 1000 tons a day; but, according to the *Chemical Trades Journal*, was found to be unsuitable, its engine power proving insufficient for working in the very hard rock-like alkali found at some distance below the surface. Suitable alterations have now been made, however, and it is anticipated, if no further unforeseen accidents occur, that production at the rate of 100,000 tons of soda ash per annum will very shortly be realised.

AMONG the subjects now in hand in the laboratories of the British Cast Iron Research Association are:—Iron suitable for moulds for glass bottles, these moulds being at present largely imported from abroad; and the magnetic properties of cast iron. The high-silicon irons now found so useful in chemical industry on account of their high resistance to mineral acids are also to be investigated. Together with the American Testing Society, the question of the standardisation of cast iron test bars is being examined, and it is hoped that an international specification can be devised.

LECTURING on the subject of "Water Power" before the Liverpool Engineering Society, Mr. D. H. Thomson pointed out that in schemes in which the load factor is low, the peak-load is usually of short duration. Rather than provide for this peak by means of additional steam plant, which must necessarily remain idle under banked fires for a large part of its life, it might prove, he said, more economical, if a suitable stream is available, to lay down water power plant for that purpose, the upkeep of which, when idle, is almost negligible. Incidentally, the load factor of the steam plant portion of the scheme would be materially raised.

THE output of the gold mines of Northern Ontario for the coming year is now estimated to reach 30,000,000 dols. This year's output is expected to exceed 20,000,000 dols., an advance of 6,000,000 dols. over 1921. Hitherto the largest output has been that of the Yukon in 1900, which reached 22,275,000 dols. Whether the figure named will be quite reached next year or not, there can be no doubt, says *Canada*, that the gold output from now on will show a steady increase, and the confident predictions of some of the most experienced mining engineers, who from their personal knowledge are able to compare the Ontario mines with those of the Rand and other great mining districts, will be fully borne out.

THE explosion of a hot-table in a London factory has induced the Engineer Surveyor-in-Chief, Board of Trade, to remark that:—"The haphazard connecting up of cast iron heating apparatus of this nature to any steam supply which is available without any regard to the pressure and the strength of the apparatus invariably results in disaster. There is usually some difficulty in ascertaining the internal condition and construction of cast iron apparatus of this kind, but it may be taken as a general rule that where large surfaces of cast iron are exposed to internal pressure the pressure used should not exceed a few pounds per square inch, and that reliable means of preventing the safe working pressure being exceeded should be fitted. Provision should be made for examining the stays, and as a rule these should be made of wrought material."

IN concluding a paper on "The Oilfields of Russia," read before the Institution of Petroleum Technologists, Mr. T. G. Madgwick said that it is disappointing that so little in the way of new structure has been developed near Baku. Of course, there is little hope for anything in the formation below those at present producing, and the principal development of Pliocene rocks, which might conceal hitherto untapped oil pools, lies on the eastern end of the Apsheron Peninsula and to the west around the lower part of the Kura River. Both these areas deserve more attention than has hitherto been devoted them. Elsewhere in the Caucasus the Grozny (Terek) region offers most inducement to the prospector; already new pools have been proved and a serious geological survey should endeavour to link up this area with that of the Emba field. The Kuban district offers prospects of similar finds to that known as the Maikop field. The southern side of the main ridge is less promising, unless concealed pools lie towards the Caspian end.

Miscellanea.

THE coal output at the mines of Great Britain for the week ended December 2nd, was 5,573,300 tons, as compared with 5,471,800 tons in the previous week, and 4,693,300 tons in the corresponding week last year.

PLANS are under consideration for the construction in China of a cement plant in the vicinity of Kayling City, which is about 150 miles inland from Swatow, on a branch of the Han River. The necessary raw materials are said to be found in abundance in this district, and it is intended to examine the possibilities of the business by establishing a small plant, which, if circumstances justify, will subsequently be enlarged.

A SEAM of almost pure salt, 6ft. thick, has been discovered at Malagash, Nova Scotia, at a depth of 200ft. Analysis proved it to be 99.1 per cent. pure. The salt hitherto mined was of good quality, but contained a small percentage of dark particles, which detracted somewhat from its value. Potash has been found at two levels in the salt strata. It is possible that purer potash will be encountered at greater depth.

ALTHOUGH amateur wireless telegraphy and telephony in France have not attained popularity so rapidly as in England, during the last few months great strides have been made, and amateur receiving sets now abound, not only in well-to-do quarters of towns and on large farms in the country, but also in poorer districts. It is no unusual thing to see wires stretched between a factory chimney and a sixth floor attic window in a working-class quarter in Paris.

ONE of the largest commercial concerns in Japan has decided to erect a factory at Hikoshima, near Shimonoseki, with a view to fixation of atmospheric nitrogen by the Claude process. Some three years ago, one of the company's engineering experts was sent to France to investigate the process, and on his return, arrangements were made to proceed with the scheme. The plant is estimated to produce 10 tons of nitrogen per day during the preliminary stages.

SOME time ago there was much discussion with regard to a proposal to link up Paris with Saint Germain by means of an aerial railway. The reason for such a project is that Saint Germain is situated on a hill which, though accessible by tramway, is nevertheless very steep. It now appears that this proposal is to receive serious consideration, for the Public Transport Commission has, at a meeting held at the Hotel de Ville, decided that the originator of the project should be asked to describe his scheme.

AN enterprise of the Bengal-Nagpur Railway which is likely to have far-reaching effects on the building trade, is its efforts to manufacture bricks of a quality at present unobtainable in India. The company is investing 12¼ lakhs of rupees in a modern brick factory, which is to be erected at Gokalpur, near Khargpur. This factory will be equipped with devices which have been patented by Mr. Colquhoun, who is in charge of the works. Power for the factory will be taken from the Khargpur electric power house. The factory will employ sixty-two men and produce 15 million bricks annually, of the type known as engineering bricks. It is claimed that bricks known in the building trade as "first-class bricks," can be manufactured in the factory at three to four rupees per thousand cheaper than the prevailing market rates.

AN exhibition of scientific novelties, which will be open until January 10th, is being held at King's College, Strand, W.C.—by permission of the College delegacy—in support of the Hospitals of London Combined Appeal. Members of the scientific staffs of the various colleges and schools of the University of London, as well as of university institutions having recognised teachers, are assisting with exhibits or demonstrations, and short lectures with experimental or lantern illustrations will be given by Professors Bairstow, Sir William Bragg, Cheshire, Winifred Cullis, Flinders Petrie, Garwood, Gordon, Macgregor-Morris, Watts, Wilson, and many others. The exhibition will not be merely a display of objects of interest, but of the character of a conversazione, in which experiments and demonstrations will be going on continuously.

AGRICULTURAL machinery importers in Argentina report a phenomenal demand this year for harvesting machinery, and that there is likely to be a shortage in the supply. In former years it has been customary for importers to sell more machines than they had in stock or on the way. Each sale contract generally contains the condition that if the farmer's crop fails, the order for machinery is automatically cancelled, and every year, under this condition, with cancellations running as high as 75 per cent. of the orders booked, implement merchants have always been safe in over-selling. A record harvest is expected this season, and the conditions thus far have been so good that practically no orders have been cancelled, with the result that merchants will most probably find themselves unable to supply the demand. After a succession of years that have been somewhat disappointing, the machinery importers are said to be viewing the changed condition with satisfaction, tinged only by regret that agricultural machinery cannot fly to the country.

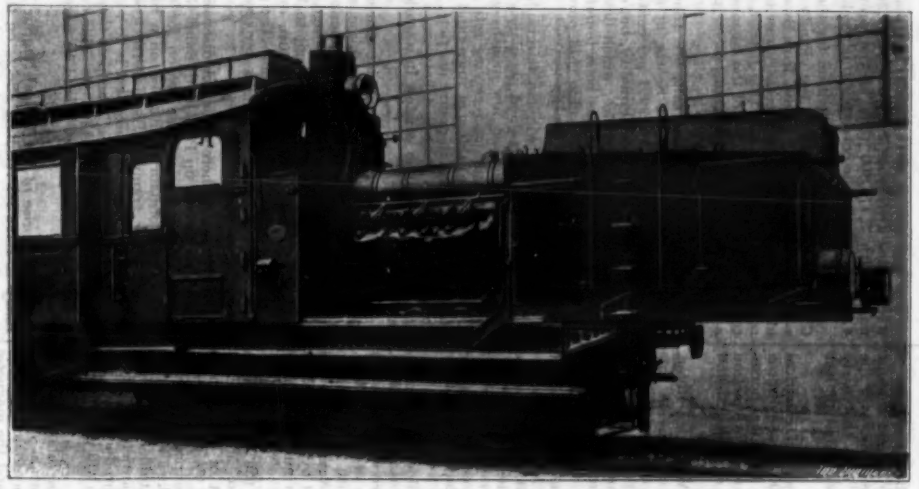
THE manufacture of Portland cement has become quite an important industry in India since 1914. The rupee capital invested is estimated at 3½ crores. In 1913–14 the imports of Portland cement were 179,000 tons. At that time India produced no Portland cement of reputation. During 1922 the output of works completed in 1914-15 was 100,000 tons. It is estimated that this year's output will be 285,000 tons, and that in 1923 the quantity manufactured will be between 600,000 and 700,000 tons. Indian manufacturers have to meet severe competition from Belgium and Germany, chiefly owing to disorganisation of the exchanges. It is stated that from now onwards India will produce much more cement than it consumes at present, and that internal competition will keep the prices fairly low. At the present moment Indian cement is obtainable in Bombay at 70 rupees per ton; whereas the cost of cement imported from Great Britain is about 90 rupees per ton, while Belgian and German cement are selling at 65 rupees per ton, and Japanese at 62 rupees.

200-H.P. DIESEL-ELECTRIC RAILWAY COACH

SULZER BROTHERS, WINTERTHUR, ENGINEERS

(*For description see page 696*)

GENERAL VIEW OF THE COACH



THE ENGINE WITH THE FRONT COVER DRAWN FORWARD

DRIVER'S COMPARTMENT AT FRONT END OF COACH

DRIVER'S COMPARTMENT AT REAR END OF COACH

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris. CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND CO., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.
ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.
JAPAN.—MARUZEN CO., Tokyo and Yokohama.
AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND CO., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND CO., Gresham-street, Adelaide.
CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS CO., 386-388, St. James-street, Montreal.
TORONTO NEWS CO., 42, Yonge-street, Toronto.
CEYLON.—WIJAYARTHA AND CO., Colombo.
JAMAICA.—EDUCATIONAL SUPPLY CO., Kingston.
NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND CO., Auckland; J. WILSON CRAIG AND CO., Napier.
STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS CO., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—BRITISH AND COLONIAL PRESS, Inc., 730, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—AGENCE VOX, 7, Rue de Surène, Paris (VIIIe).
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SOUTH AMERICAN BRANCH OFFICE OF

The Engineer,

526, Bolsa de Comercio, Buenos Aires.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly	£1 11s. 6d.	Half-yearly	£1 13s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum
Thick paper edition .. .. £3 3s. 0d. „

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of THE ENGINEER.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, December 29th, 1922. PAGE

RECENT AND FUTURE LOCOMOTIVE DESIGN IN NEW SOUTH WALES 681
ROADS IN NORTH CHINA. (Illus.) 682
THE MILL CLOSE LEAD MINE 684
A STUDY OF AIR-STEAM MIXTURES 684
A THORNYCROFT MOTOR YACHT 685
AUSTRALIAN ENGINEERING NOTES 686
LETTERS TO THE EDITOR—
Errors in Gauging 686
The Human Side 686
A SEVEN-DAY JOURNAL 687
A HEAVY-DUTY VERTICAL-SPINDLE SURFACE GRINDING MACHINE. (Illus.) 688
BROWN COALS AND LIGNITE 688
THE BRITISH CAST IRON RESEARCH ASSOCIATION 689
CONSOLIDATION LOCOMOTIVE FOR THE VICTORIAN RAILWAYS. (Illus.) 689
ELECTRIC WELDING APPARATUS AND EQUIPMENT 689
A NEW VICE. (Illus.) 690
RUNNING AND OPERATING MARINE DIESEL ENGINES 690
RAILWAY MATTERS 691
NOTES AND MEMORANDA 691
MISCELLANEA 691
LEADING ARTICLES—
Standardisation Again 693
Safety Regulations for Saw Mills 693
Highway Construction in China 694
THE PARIS AERO SHOW 694
RAILWAYS UNDER GROUPING 695
SHORT NOTICES 695
THE SULZER DIESEL-ELECTRIC RAIL CAR. (Illus.) 696
OBITUARY—
James Rigg 699
BOOKS RECEIVED 699
PROVINCIAL LETTERS—
The Midlands and Staffordshire 699
Lancashire 699
Sheffield 700
North of England 700
Scotland 701
Wales and Adjoining Counties 701
CATALOGUES 701
PERSONAL AND BUSINESS ANNOUNCEMENTS 701
CURRENT PRICES OF METALS AND FUELS 702
FRENCH ENGINEERING NOTES 703
BRITISH PATENT SPECIFICATIONS. (Illus.) 703
FORTHCOMING ENGAGEMENTS 704

THE ENGINEER.

DECEMBER 29, 1922.

Standardisation Again.

WE were delighted to find in a direction where we should hardly have sought it, support for views upon standardisation which have been frequently expressed in the columns of THE ENGINEER. In a brief editorial in its issue of November 7th, the *Motor* commented upon a remark made by Colonel Smith, the new President of the Institution of Automobile Engineers, that the world's most popular car was as an object lesson in the advantages of standardisation. After alluding to the present position and probable future of the Ford car and pointing to the increasing popularity of the all-British small car, our contemporary said: "There is a lesson in this, which is that standardisation can be misunderstood and misapplied. British cars, generally, stand or fall by continual progress in design, and anything in the nature of standardisation which hampers that progress will reflect upon the industry. It is also apparent, even in the cheapest cars, that there must be progress, for so soon as one car becomes backward in design a competitor will appear—possibly from another country—and usurp the position that it has held." The article concluded with a commendation of the standardisation of details. But this is not the only support our views have received in the past few weeks, for in the discussion on Sir Vincent Raven's paper at the Institution of Mechanical Engineers several references were made to standardisation, and without exception they opposed it in connection with the design of electric locomotives.

We are delighted to find views that have in their time been dubbed reactionary thus gaining ground, not because such support is gratifying to ourselves, but because we are confident that progress consists in allowing the greatest possible latitude to designers. There is only one defence for standardisation. It leads to a reduction of cost of manufacture. Apart from that one merit—the value of which we do not depreciate—it has nothing to commend it, and is only tolerable when we can say with positive certainty that a limit to progress has been reached, that no modification can ever be better, and that human ingenuity has attained its zenith. Of how many things within the sphere of engineering dare we make such an assertion? To do so, of even the smallest, would be to deny all the lessons of technological history, and to claim arrogantly a degree of knowledge which it is impossible we can possess. The adoption of a standard imposes, as we say, a limit; to that limit we may agree as a matter of convenience—as in the work done by the British Engineering Standards Association or as in the making of some particular machine. Henry Ford, to take the obvious example, set out to make the cheapest possible car and fixed closely the limit to which he could go. He standardised rigidly within that limit. Railway works, again, fix their limits for boilers, cylinders, motions and so on. The sewing machine makers produce definite types within carefully considered limits. In all these cases technical progress is hindered by the standards; the makers themselves cannot get outside the ring fence which they have set up, and in many cases they use their whole endeavour to prevent others from destroying that fence. The experience of a certain illustrious firm which tried to get into the sewing machine trade is well known. Internal standardisation, as it may be called, is generally desirable; it is sound commercial engineering. But even it becomes a danger when carried too far. Who can doubt that the Ford car has arrested the progress of cheap car design in America? The Ford Company occupies such a vast field that it is extremely difficult for others to find standing room. We agree with the *Motor* that the conditions in this country are more healthy, more progressive. Here we have a score or more makers all turning out cheap cars, and each endeavouring to do better than his rival. That way development lies. But if internal standardisation has such disadvantages, how much greater are the disadvantages of external or general standardisation. Suppose we should decide, now at once, to set up certain standard designs of electric locomotives, what would be the result? Is it not obvious that a measure of restriction would be placed on designers, that inventors would have less freedom of action, that we in this country should be limited in our scope, and that we should have, perchance, to suffer the chagrin of witnessing advances in foreign designs, whilst our own remained stationary. We have here no practical intimate knowledge of electric locomotives. We do not know what the future has in store. To put even the mildest restrictions on our freedom of movement, to do no more than fix upon certain wheel arrangements, would be unwise; to go further would be disastrous. We have resisted the standardisation of steam locomotives which have a hundred years of history behind them; how much more is it necessary to resist the standardisation of electric locomotives which, in Great Britain, have as yet no history? Years and years ago the British railway gauge was standardised. There were far, far greater reasons for doing so than there are for standardising locomotives, but we should be glad to know if there is a single locomotive engineer who is satisfied with that gauge. Any standardisation of electric traction, even the 1500-volt direct-current supply, seems to us premature. Sooner or later such restrictions are regretted; let us at any rate delay their imposition as long as possible.

Standardisation is defined by its opponents as a rut, and by its supporters as a highway. Both are right; it is a highway through a cutting whose banks prevent excursions into new fields, and so puts a check upon adventure. It has grown upon us because it appeals to the manufacturing engineer, and manufacturing engineers are rapidly replacing the old mechanical engineers who did not like manufacturing, who wanted to make every individual job a little bit different, a little bit better, than the last. That kind of engineering has nearly gone; there is no money in it. But unless there is a persistent quota of it, progress will unquestionably cease. In the railway world we want men like Sir Vincent Raven himself, men, that is, who are prepared to try new experiments and break fresh ground, men who do not want to be bound down by standards and who gib now and then at even the standardisation of parts. The thoroughly standardised works dislikes new inventions and new designs. They upset its machine tools, its route-ing, its jigs and rigs, its scheduling. It opposes progress because progress to it means the jetisoning of plant. But it gives us cheap and rapid production without which the modern world would cease to turn round, and for that reason it must be borne with. Yet it must not be allowed to go too far. General standardisation must be kept within the narrowest economic limits, and encouragement must be held out to the adventurous souls who seek improvement by departure from the ordinary.

Safety Regulations for Saw Mills.

THE new Home Office regulations for the protection of operatives in all factories where wood is converted are to come into force generally on January 1st. Certain of them, however, which will entail altering, and possibly in some cases scrapping, existing and serviceable machines, are not to take effect until March 1st. In a number

of cases the endeavour of these regulations is to enforce by law measures which are already taken voluntarily and universally as a matter of course, such, for example, as providing striking gear for stopping and starting a machine and a "push-stick" for certain hand-fed machines in case the operator may wish to use it. Some of these regulations, and by far the most practical of them, provide for adequate natural and artificial lighting, proper spacing of machinery, level, unbroken and unencumbered floors and passages between the machines, and for the shrouding of running shafts, gearing and belts. These are all precautions of a salutary and essential nature, and although most sawmill owners already see to these matters in their own interests, there are unquestionably many who do not. It is just as well, therefore, that these latter should have it made clear to them that neglect of these precautions will henceforward constitute a legal offence.

Unfortunately, there is no clear definition of the meaning of the word "adequate" as applied here. That debatable point, which hitherto has been fought out between owner and the Employers' Liability Act, *after an accident*, is not removed, but it seems that in the future it is to be fought out between the owner and the Factory Inspector *before an accident*. In any case it would clearly be unfair to hold an owner responsible for accidents after he had satisfied the Factory Inspector that he had fulfilled in advance all the elaborate though vague conditions laid down in these regulations. But there is much in this document which is explicit enough, and it is here that it becomes clear that those who have framed these regulations have but a superficial knowledge of the real dangers of wood-working machines. For instance, these rules apply only to certain types of circular and band saws, planing and moulding and mortising machines, while all other and many equally dangerous machines are completely ignored. To quote only a few cases. All circular saws, with one exception, must not only be so shrouded above the table that it will be extremely difficult for an operator to see what he is doing, but the portion which is below the bench and is usually enclosed in a box casting must also be completely enclosed between two metal screens. This regulation specifically includes rack benches in which the lower part of the blade revolves in a trough below the floor and in which it would be extremely difficult for the operator to get nearer than 3ft. to the blade when it is running and whose normal position is much farther from it. The irony of it all is that swing saws are expresly excluded from these precautions, although they are the most dangerous of all, as in some designs they revolve within a few inches of the operator's face. Of all saws the swing saw is the one which it is the most necessary to shroud, and in which shrouding can be done the most easily without hampering the operator. The provisions with regard to band saws are equally illogical. Small band saws, where the tooth speed is comparatively slow and the momentum so small that they stop instantly when they break, must have their bottom pulley protected both before and *behind*, although nothing can possibly get near it at the back, and if the blade is forced off it at the back it can occasion no accident. On the other hand, the top pulley must only be shrouded *in front* by a guard of "sheet metal or other suitable material." The effect of an opaque guard so placed is to make it impossible for the operator to see the position in which the blade is running on the pulley, and this is the most important thing for him to do if he is to avoid an accident on a small band saw. Now, with all these elaborate precautions with regard to the small machine, the log band saw and the high-speed re-saw, with a tooth speed of from 8000ft. to 10,000ft. a minute, and where a broken blade, for a second or two, may gyrate about the shop and cut off a man's head in the process, are not obliged under these regulations to have any guard whatsoever. Perhaps the most incomprehensible of these regulations, and certainly the one that will cause saw-millers the greatest immediate trouble, is that which renders it compulsory to place circular cutter blocks on all hand-feed and "over-and-under" planing machines. It is said that this extraordinary measure has been taken owing to a totally erroneous impression that the circular block is less dangerous than the square block. In any case the one function of the circular block is to enable users to increase the size of their cutter tracks and carry more knives than are possible on the square block so that they may be able to attain the highest possible rates of feed, viz., from four to six lineal feet per second. It is palpably impossible to attain more than about a fifth of that speed on either the hand or the over-and-under planer, and it is equally clear that of all planers they are the very two on which a square block is much to be preferred. The reason is that the great defect of the circular block is that it creates but little draught and, without a pneumatic installation, it is difficult for the chips to get away. This is particularly so with regard to the over-and-under planer.

Fortunately, after elaborating all these and many more precautions, which, if carried out literally and in their entirety, would render efficient wood conversion almost a practical impossibility, some clauses which make some think that those who are responsible for these regulations have no great faith in their practicability are added. Thus, the regulations provide that if it can be shown that the work cannot be carried out when these precautions have been taken *they need not be applied*. Again, they can nearly all be evaded "if it can be shown that other safeguards are provided and maintained." Finally, although the operator is solemnly enjoined to make use of all these cumbersome and irritating appliances, he is totally exempted from doing so at all by the following words in the same clause:—"except when, owing to the nature of the work being done, the use of the guards and appliances is rendered impracticable." Truly it is a little difficult, in such circumstances, to understand why the regulations were ever framed. Their effect unquestionably will be to put those people who try to carry them out to much expense and lasting inconvenience, and those who do not will be put to much trouble in making it clear to Factory Inspectors that many of them are "impracticable" within the meaning of the regulations, whatever that may be.

Highway Construction in China.

In our issue of November 3rd we published an article on the road transport problem in China, and indicated the difficulties which must be overcome before any system of roads can be put in such a condition as to withstand the long-established practices of that country; but, as we have already suggested, there is no question that many and extensive roads must be, and will be, constructed and maintained in China in the near future. Some notes sent by our Peking correspondent, and printed on page 682, emphasise these difficulties, but incidentally show that the Chinese themselves are alive to modern requirements and will probably before long call on European assistance to a far greater extent than heretofore in improving their internal communications. In this connection, it is noteworthy that our correspondent comments on the excellence of the roads in the territory controlled, until recently, by the Germans, and, on the other hand, on the difficulties experienced by road-making engineers in other districts in coping with vested interests. It is our firm belief, after some considerable personal experience with the Chinese, that these ideas, which the average Englishman has, of the—shall we say?—obstinacy of the Chinese are very much exaggerated, and that the native conservatism can be overcome by a little persistence and the exercise of a certain degree of authority. The educated Chinese fully appreciate the benefits which will accrue to their country if the means of internal communication are improved, and several of the tuchuns have already given evidence of this breadth of view by using military labour for road making; but up to the present very little in the way of making roads for more than local service has been carried out. It is possible, however, that with European engineering assistance and with the disciplinary backing that European financial participation would naturally entail, there would develop a vast policy of road making in China which would inevitably react on our engineering trade, not only directly on account of the concomitant requirements for road-making machinery, but also through the subsequent improvement in the means of communication throughout the country. It must not be thought, however, that larger orders for road-making machinery are likely to be issued in the near future, for it will probably take some little time before the real benefit of the new movement is felt.

The Paris Aero Show.

(From our Correspondent in Paris.)

The Aero Show in the Grand Palais, Paris, conveys an impression of the great importance attached by the French to aviation rather than of any noteworthy achievement in the technical development of the industry. If civil and military aviation has not grown more considerably during the year, it is solely because the limited credits available have checked developments, and yet more money is probably being spent in France upon subsidies for commercial aviation than in any other country. The policy is to encourage commercial aviation and assist technical research, and at the same time organise the military and naval air services until such time as funds are forthcoming to carry out an active development. In the debate upon the Estimates the importance of aviation as a means of national defence was strongly insisted upon, and the Government was urged to make sacrifices to ensure its highest possible efficiency. It cannot be said, however, that the machines exhibited in the Grand Palais represented so much technical progress as might have been expected in view of the encouragement that has been given to research and experimental work. There were no departures from recognised principles. There was indeed a tendency to concentrate effort along certain definite lines. Whatever may be the new ideas and departures being worked out in the factories and laboratories, there was little evidence of them in the Grand Palais. Makers have evidently abandoned all hope for the moment of doing anything with light machines for private use, which were a feature of previous Exhibitions, and are engaged almost entirely in building aeroplanes for commercial companies and for the State. Nearly all the machines shown were big commercial and bombing planes, seaplanes and fast scouting machines.

The metallic construction of aeroplanes has always been regarded with a certain prejudice on the ground that an accident usually results in the entire loss of the machine, while a machine built of wood is more flexible and less liable to serious damage from landing shocks and can often be easily repaired. Nevertheless, several firms are building machines of duralumin, and Messrs. Schneider and Co. are employing a special light alloy of their own in their huge bombing biplane, which has a span of 30 m. and a length of 20 m. Its total weight in flying order is 10 tons. On each side of the fuselage is a pair of Lorraine-Dietrich 275 horse-power engines driving propellers fore and aft, thus making a total engine power of 1100 horse-power with four propellers. Each plane is made in two sections, the outer section having its edge set at an angle to the line of the central plane. This practice of making planes of considerable area detachable in two parts was also observable in the huge seaplane shown by Bellenger Frères, who have only recently entered the aviation industry. In this seaplane the wings are hinged in the middle to permit of their being folded back and save space in the shed. One reason apparently for the increasing prevalence of metallic construction is the necessity of dispensing with wood in machines employed in tropical countries. It is expected that Africa will provide the widest field for aviation activities in the early future, and all the makers are looking to this source of business, which is likely to be confined to all-metal aeroplanes. The Latecoere machines with Hispano-Suiza engines, one at the end of the fuselage and one on each side, are effecting regular services between France and Morocco and between Casablanca and the interior, while military aeroplanes are largely employed for communication with the less accessible parts of West Africa. Judging from the general tendencies of construction, there is an increasingly marked distinction between commercial and military aeroplanes, from which it is clear that the former would have little value for national defence other than as a means of transport. The two Breguet machines strikingly illustrated this difference. In the military aeroplane, constructed entirely of metal, one half of the fuselage is taken up with the four engines in two groups, developing 1000 horse-power and driving one propeller. One pair of engines is placed behind and above the other, a special feature being the clutching device which ensures a solid drive when all four engines are running at the same speed. Behind the engines is a compartment containing the petrol tanks and a receptacle for a dozen bombs. The pilot's seat is right back behind the compartment and the planes, and then there is a cockpit with a machine gun. Both wood and metal planes were shown by Hanriot, and Henry Potez, who last year exhibited small machines for training purposes and for private use, showed an all-metal commercial aeroplane for carrying twelve passengers. It was fitted with three Lorraine-Dietrich engines of 275 horse-power each. The Henry Potez Company has established a very extensive factory for the construction of aeroplanes, and other firms have also extended their works, with the result that the country's manufacturing facilities have enormously increased during the year, and there is no doubt that large fleets of commercial and military aeroplanes can be turned out as soon as the financial position permits of a further development of aviation.

In monoplanes there is a marked tendency towards adopting the thick wing section without struts and stays, on the lines of the Fokker, which was refused admission to the Salon this year. A monoplane on this principle was shown by Farman, and the Morane-Saulnier, which was probably a precursor of the Fokker, has the fuselage suspended from the plane without stays, but in no case was an attempt made to follow the special stream lines of the Dutch machine, whereby a depression is obtained on the upper surface with the idea of increasing the lifting power. Another

novel machine in which the same principle of construction is involved was that shown by the S.I.M.B., the thick section plane being built into the lower part of the fuselage and the landing chassis constituting a hollow metallic receptacle in which is placed the oil tank. The design aims at reducing air resistance, and the problem of increasing speed and altitude by the use of powerful engines appears, indeed, to occupy the attention of French builders of monoplanes to the exclusion of everything else. There was an almost entire absence of light and medium-powered machines, probably because the solution of the privately owned aeroplane is expected to be found in the development of the glider equipped with a small and economical engine. A special section was devoted to the gliders taking part in the Combegrasse trials.

The foreign participation was not so great as in previous years. It was restricted to a Handley-Page machine and to a seaplane constructed by the Sesto Company, of Calende, Italy. Nor was there anything new in the way of practical ideas. The failures of so many novel devices in the past have momentarily put a check upon inventive ingenuity. The Pescarra helicopter was shown in practically the same form as last year. A vast amount of experimental work has been carried out with this machine, which rises from the ground and demonstrates the soundness of the principle, but it is still far from having a practical value. In fact, it cannot be said that the aeroplanes exhibited represented any real technical advance, although many of them showed a marked improvement in construction and equipment.

The progress of aviation is to be measured by the advance in engine design and construction. So great is the need for a satisfactory engine that the Government is offering a million francs for the best aviation engine taking part in a competition to be organised in the coming year. For the moment, there are curiously fluctuating ideas concerning the respective merits of the purely aviation type of engine with radial air-cooled cylinders and the light engine evolved from the motor car type. The first successful attack on the radial type was made by the Hispano-Suiza, which is now employed on a large number of commercial aeroplanes. The Hispano-Suiza engine has eight cylinders arranged V fashion, with overhead valves, and the reduction in weight is obtained by making the best use of high-resistance steels. High compressions, double valves, two plugs in each cylinder to ensure a more instantaneous and complete combustion and other details aid in giving more power in proportion to the weight. This type of engine has the advantage of benefiting from long experience in automobile engine practice, and is therefore regarded as offering greater reliability under conditions where the coefficient of security is necessarily small. Of this type also is the Lorraine-Dietrich, which is largely employed on commercial and bombing aeroplanes. In striving for higher powers, makers increase the number of cylinders rather than the cylinder capacity, and in the latest Lorraine-Dietrich 1000 horse-power engine there are twenty-four cylinders of 126 mm. bore and 200 mm. stroke arranged in one vertical and two inclined groups, known as the W type. A similar arrangement is adopted in the new 400 horse-power twelve-cylinder Farman, the cylinders in this case being cast in pairs, which allows of the induction pipes passing between the two pairs of each group. The cylinder dimensions are 130 mm. by 160 mm., and it is claimed that the consumption of petrol is 220 grammes per horse-power-hour. The total weight of the engine is 560 kilos. The latest aviation engine of this class is the 600 horse-power Peugeot, with twelve cylinders, 160 mm. bore and 175 mm. stroke. There are three cylinders in one casting, and four groups of three, arranged V fashion. Makers of automobile engines are satisfactorily meeting the requirements of aviation firms, and for the moment development is proceeding along these lines. It is difficult to see how much more can be got out of the four-cycle engine.

Railways Under Grouping.

THE Railways Act, 1921, by Sec. 1, ordered that the railways of Great Britain should be divided into groups, to be formed as specified in the first schedule in the Act. Some companies—to be known as constituent companies—were to be amalgamated, and the others—called subsidiary companies—were to be absorbed. There were twenty constituent companies and ninety-three subsidiary. Of the latter, twenty-six were working companies and sixty-seven were leased to, and worked by, larger companies. The constituent companies were given until January 1st, 1923, to submit an agreed amalgamation scheme, and the amalgamated companies, *i.e.*, the complete groups, were to submit an agreed absorption scheme by the same date. Failing agreement, the Railway Amalgamation Tribunal was to prepare a scheme.

It must be acknowledged that, as regards the constituent companies, the most sanguine expectations have been more than realised, as, of the twenty companies concerned, only one—the Caledonian—remains to be dealt with. Whilst less progress has been made with the subsidiary companies, the Southern Group has secured all but two of its fourteen, and the Great Western all but three of its twenty-six. What, throughout this article, we call the Midland Group has, on the other hand, only come to terms with five out of twenty-seven, and the North-Eastern Group with none of its twenty-six, if we neglect the fact that two are jointly owned by companies now in that group. When we say that terms have not been arranged, we should, perhaps, make the qualification that no public announcement of such arrangements has been made.

In view of the fact that, with the exception of the Caledonian, the twenty constituent companies will become four as and from Monday next—January 1st—some particulars of what the financial and physical condition of the railways will be when the section of the Act has taken full effect will be of interest. It is important, first, to note what companies are not provided for under the grouping scheme. There are, for instance, ten in London and two in Liverpool which operate electric railways—we give the status of "company" to all shown in the last Railway Returns, those for 1921, as having created capital—and there are eleven jointly owned companies with a capital account of their own, independent of that of the various owning companies. Excluded from this list are the concerns owned jointly by two companies which are now in the same group, and which properties will no longer be joint. Then there are forty-one light railways which are also exeluded.

CAPITAL CREATED.

At the end of 1921 the total amount of capital created by the railways of Great Britain was £1,318,377,747, and on the 1921 basis it will be allocated as follows:—London, Midland and Scottish (hereinafter called the Midland), £530,761,951; London and North-Eastern (hereinafter called the North-Eastern) £367,576,342; Great Western, £162,907,046; Southern, £160,101,951; electric railways, £78,309,026; jointly owned railways, £13,260,379; light railways, £5,461,052. The last three take 7.36 per cent. of the whole, and therefore call for attention.

LENGTH OF LINE.

The route mileage for British railways was 20,281 m. 46 c., divided as follows:—Midland, 7223 m. 76 c.; North-Eastern, 6719 m. 9 c.; Great Western, 3774 m. 51 c.; Southern, 2199 m. 76 c.; electric railways, 138 m. 37 c.; light railways, 225 m. 37 c.

The track mileage was 36,751 m. 37 c., divided as follows:—Midland, 13,777 m. 23 c.; North-Eastern, 11,969 m. 67 c.; Great Western, 6280 m. 14 c.; Southern, 4198 m.; electric railways, 288 m. 12 c.; light railways, 238 m. 1 c.

The total length of sidings was 14,726 miles, allocated as follows:—Midland, 5942 m. 54 c.; North-Eastern, 5192 m. 43 c.; Great Western, 2270 m. 46 c.; Southern, 1204 m. 16 c.; electric railways, 77 m. 28 c.; light railways, 38 m. 53 c.

In this table of the Railway Returns the proportions of jointly owned lines are credited to the owning companies. Particulars of the lengths of joint lines are given, and show that included in the above figures are 723 m. 76 c. route length, 1220 m. 17 c. track length, and 364 m. 3 c. of sidings that remain jointly owned.

ROLLING STOCK.

The 14,660 tender and 9671 tank engines of the kingdom were divided as follows:—Midland, 6926 tender, 3350 tank; North-Eastern, 4852 tender, 2634 tank; Great Western, 1551 tender, 2432 tank; Southern, 1177 tender, 1118 tank; electric railways, 39 tank; joint lines, 143 tender, 40 tank; light railways, 11 tender, 58 tank.

The figures as to carriages we are about to give are independent of electrically worked lines. The 48,820 carriages, with seating accommodation for 2,466,976, were allocated thus:—Midland, 19,155 carriages, 974,134 seats; North-Eastern, 14,355 carriages, 716,028 seats; Great Western, 6649 carriages, 339,415 seats; Southern, 7394 carriages, 378,505 seats; electric railways, 88 carriages, 5852 seats; joint lines, 905 carriages, 42,162 seats; light railways, 274 carriages, 10,880 seats.

The 390,697 open merchandise, 86,805 covered merchandise and 186,426 mineral railway-owned wagons were divided thus:—Midland, 172,730 open, 38,794 covered, 76,443 mineral; North-Eastern 129,455 open, 26,183 covered, 102,227 mineral; Great Western, 62,093 open, 16,093 covered, 996 mineral; Southern, 22,274 open, 4752 covered, 5309 mineral; electric railways, 465 open, 44 covered; joint lines, 3318 open, 904 covered; light railways, 362 open, 35 covered, 1449 mineral.

We would explain that some companies, *e.g.*, the Great Northern and the late Lancashire and Yorkshire, use open merchandise wagons for the conveyance of coal and so have no so-called mineral wagons.

BUSINESS DONE.

The number of passenger train miles run, including electric, was 205,415,970, made up of:—Midland, 68,546,632; North-Eastern, 49,398,694; Great Western, 29,778,067; Southern, 33,961,458; electric railways, 21,020,390; joint lines, 1,397,637; light railways, 1,313,092. The number of passenger journeys, excluding those by season ticket holders, was 1,229,423,512, allocated as follows:—Midland, 318,757,552; North-Eastern 227,575,401; Great Western, 112,682,457; Southern, 173,291,428; electric railways, 354,577,320; joint lines, 29,160,115; light railways, 13,379,239.

The goods train mileage total was 109,708,783, and it was made up thus:—Midland, 47,115,015; North-Eastern, 36,226,412; Great Western, 19,005,911; Southern, 6,012,915; electric railways, 158,755; joint lines, 976,226; light railways, 213,549. The tonnage carried was 217,881,283, which originated thus:—Midland, 83,576,660 tons; North-Eastern, 78,265,388 tons; Great Western, 41,036,476 tons; Southern, 7,158,395 tons; electric railways, 24,719 tons; joint lines, 6,740,582 tons; light railways, 1,079,063 tons.

It will be seen that as regards passenger train miles and passengers carried, the Great Western is lower than the Southern, and that as regards length of line, it loses its pride of place as being the longest in the kingdom. It is now the third in this matter and less than one-half the length of the Midland.

NUMBER OF RAILWAY SERVANTS.

The Stationery Office publication, Railway Companies' Staff, gave the number of servants employed by thirty-two companies on March 25th last. The total was 661,729, and we allocate them as follows:—Midland, 261,685; North-Eastern, 200,999; Great Western, 105,093; Southern, 71,305; electric railways, 13,541; joint lines, 9106. The remaining companies, not named in the White Paper, had 11,577 servants.

SHORT NOTICES.

The All-electric Age. By Adam Gowans Whyte, B.Sc. London: Constable and Co. Price 7s. 6d.—The object of this work, which incidentally is written in a clear and interesting manner, is apparently to familiarise the public with the many uses of electricity. Other books of a similar kind have, of course, been written, but many of them are now out of date and no longer serve to indicate the true position of the electrical industry. The present volume, however, deals with all modern electrical matters which are of general interest, such as electric lighting, heating and cooking, road and rail transport, electrically driven domestic labour-saving appliances, electric fans, electric medical appliances, telegraphy and telephony, super-power stations, and so forth. As the title of the book implies, the author's object is to hasten the coming of the all-electric age in which work that is distasteful and laborious will be reduced to the simple process of pressing buttons. By means of pictures and nicely written essays the author shows how easily the many objectionable domestic jobs can be accomplished with the aid of electricity. The all-electric home, with its electrically driven washing and sewing machines and vacuum cleaner, electric radiators and oven, and possibly an electric motor car, is clearly one of the author's pet ideas; but we are rather afraid that, unless supply undertakings can see their way clear to let consumers have cooking and other appliances on better terms than those which generally prevail, the advantages which accrue from electrical methods will only be enjoyed by a few. Nevertheless, the work will, we think, serve to enlighten many people who have not as yet looked into the possibilities of electricity, not only in the home, but in the factory and elsewhere.

Railway Permanent Way: Dimensional Theory and Practice. By William Hepworth, Assoc. M. Inst. C.E., and J. Thomas Lee, Mem. Per. Way Inst. (Gold Medallist). Manchester: Chas. Sever, 40, King-street West. Price 12s. 6d.—In comparison with the literature on locomotives there has been very little written about the track. Yet it plays an equally important part. There is, though, very little sentiment about the permanent way and very little change. We had been inclined to add that, unlike the locomotive, it has no charm of design; but after seeing the two views—of Southport, we believe—on page 395 of this volume, we are disposed to argue that crossover roads, scissors crossings, slips, &c., may be made things of beauty. It is surprising, then, to find that our present authors have been able to put together over 400 pages on the subject; moreover, this has been done without any one branch receiving greater attention than another. It is a pleasure to review this work, as it is written with that practical acquaintance with the track that appeals to a railway engineer, and which is expected of such men as the authors, who hold responsible positions on what was the Lancashire and Yorkshire Railway. But the book is more than practical; it deals with theory also, and this to the same valuable degree. Of yet greater importance, it meets the needs of permanent way inspectors and foremen, and, to quote some very true words in the preface, "that large class of manual workers in whose ranks are many thoughtful and intelligent men who take a real interest in their work."

Annuaire des Ports Belges, 1922 Edition. With a preface by Mr. L. Strauss. London: R. G. C. Panels, Limited, 13, Brecknock-road, N. 7. Price 90f.—The new edition of this directory has just been received. Published under the auspices of the Chiefs of the Belgian Government Departments, it may be taken as a semi-official production. The directory has been divided into sections and deals with general matters; particulars of the Belgian ports with maps and pictures; internal means of communication with the surrounding countries; and a section devoted to the industries of Belgium. In addition to the foregoing a section has been embodied on the Belgian Congo, with full particulars as to its productions and facilities for export. The book, which has been carefully revised, should prove useful to British manufacturers, exporters, and other firms concerned in overseas trade.

THE Imperial Steel Works at Yawata, Japan, has completed construction of its plant for making tin-plate. Its estimated annual capacity is 20,000 tons, although the first year's production is not expected to exceed 6000 tons.

The Sulzer Diesel-Electric Rail Car.

DIESEL LOCOMOTIVES.

THE problem of the internal combustion locomotive has proved attractive to many engineers, and it has in particular engaged the attention of Diesel engine builders, who early recognised in the Diesel locomotive a development not less important than that of the stationary or marine type of engine. The adoption of the Diesel principle achieves a much greater saving in fuel cost than that which is possible with the petrol locomotive, while the more robust construction of the Diesel engine is a factor undoubtedly favourable to its adoption for the more arduous services of main and branch line railway work. One of the first large Diesel locomotives built and run was the thermo-locomotive delivered early in 1913 to the Prussian State Railways. That was a 4–4–4 express locomotive with a two-stroke cycle four-cylinder Sulzer engine driving direct by means of coupling rods on to the main centre driving wheels, the engine cylinders being placed in pairs opposite to each other in V form. The main engine was designed to develop about 1000 horse-power, giving train speeds up to 60 miles per hour. The starting, injection and scavenging air for the main engine was supplied by an auxiliary engine of 250 horse-power, to which the air compressors and scavenging pumps were attached. The control of the engine, including the starting and the adjustment of the load to the speed, was accomplished by an ingenious mechanical arrangement of valve and compressor controls. Shortly after this locomotive was put into service orders were received by Sulzer Brothers for a Diesel-electric rail car in which the power developed by a Diesel engine was utilised by an electric generator supplying current to motors geared direct to the driving axles. Five of these rail cars were ordered, two for the Saxon and three for the Prussian Railways. Those for the Saxon Railways were delivered and underwent satisfactory trials before the outbreak of war. During the war and after, conditions in Germany proved such that further experimental and extension work in this direction was not possible, and it was eventually decided by Sulzer Brothers to purchase these rail cars and embody in their design improvements both mechanical and electrical which, in the meantime, they had perfected, along with Brown, Boveri, of Baden, which firm was associated with Sulzer Brothers in the design of the electrical equipment. It is with the new rail car and its performance under service conditions that we propose to deal.

FIG. 1—THE COACH DRAWING THREE TRAILERS

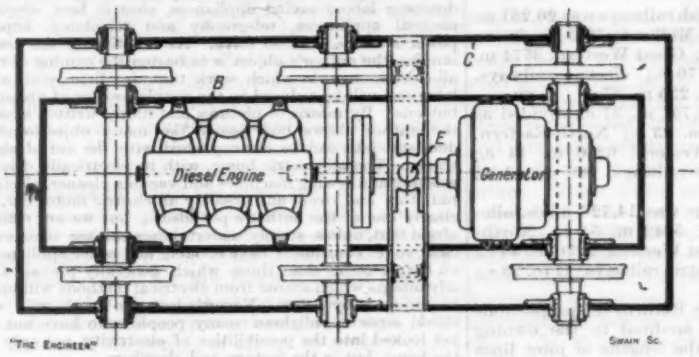


FIG. 2—ARRANGEMENT OF THE FRONT BOGIE

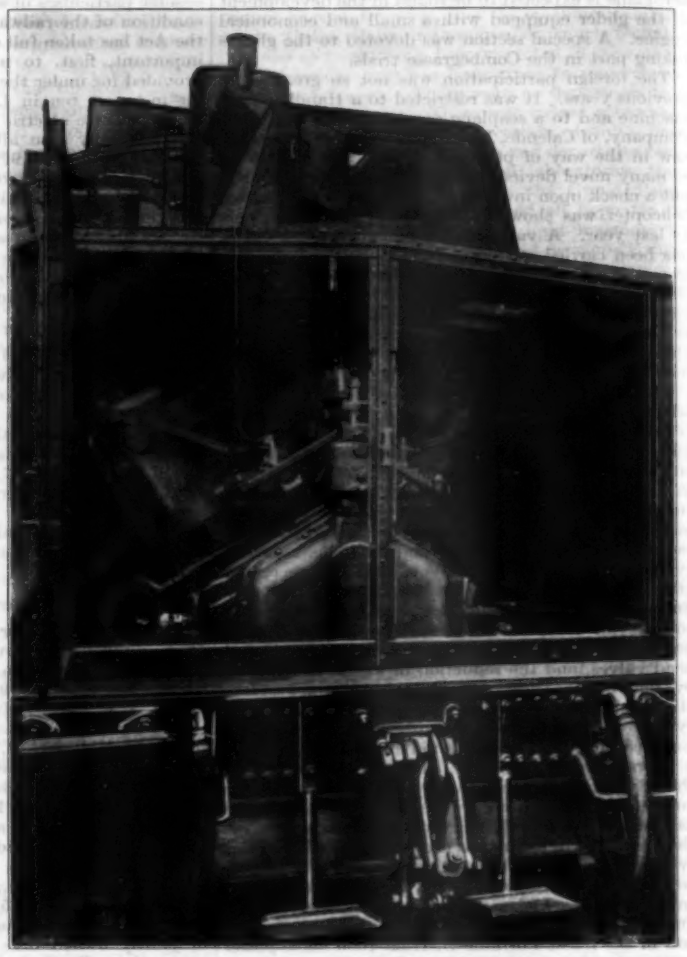


FIG. 3—FRONT END VIEW OF THE ENGINE

THE DIESEL ELECTRIC RAIL CAR.

In the original design the six-cylinder four-stroke cycle Diesel engine of 200 horse-power was arranged for burning tar oil with pilot ignition, and direct-driven compressors supplied the air for starting, fuel ignition, and for minor purposes, such as brakes, sand pipes, and whistle. In the new design electric starting was adopted, the generator being re-wound for this purpose and the necessary accumulators provided. A great simplification in the engine was made possible by the introduction of the new R V type injection valve, by means of which the fuel is injected directly into the cylinder without the use of injection air, the necessary pressure being obtained by combustion of a part of the fuel itself. Thus the entire compressor installation was dispensed with, along with the intricate valve and controls.

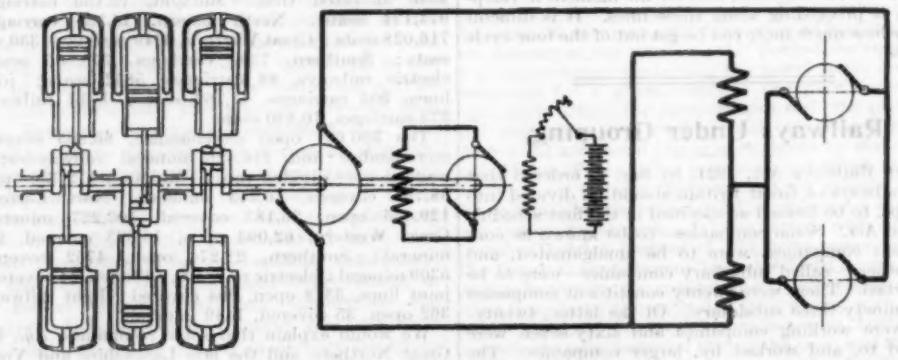


FIG. 4—DIAGRAM OF ELECTRICAL CONNECTIONS

A general idea of the arrangement of the rail car and its equipment will be gained from the illustrations on page 692 and Figs. 1 and 3. In Fig. 1 the car is shown attached to three trailers, for it was built for branch line service alone, or for the haulage of light trains. The drawings reproduced on page 697 and in Fig. 6 also give detailed particulars of the engine and car arrangement, from which it will be noted that the body of the car rests on two bogies, one of which has three axles and the other two. The three-axled bogie—a sectional plan of which is shown in Fig. 2—supports the Diesel engine, which drives the direct-current generator through an elastic coupling. The generator is fitted into a special frame B, which is connected through springs to the bogie C, while the spherical pivot E takes the weight of the upper part of the car. This pivot is shown in vertical section in the lower view—Fig. 5. The two direct-current motors driving the axles are arranged on the two-axle bogie. They are mounted on a common cast steel casing and through duplicate pairs of wheels drive an idle shaft, from which crank discs and coupling rods transmit the power to the driving wheels.

INTERNAL ARRANGEMENT OF CAR.

As will be seen from the various illustrations reproduced, the car is of the standard-gauge passenger type. It has an overall length over the buffers of approximately 70ft. Entrance and exit is made through the roomy driving platforms which are provided both at the engine and motor ends—interior views of which are shown on page 692—these driving platforms being separated from the interior of the car by sliding doors. The car has seating accommodation for sixty-nine passengers, with standing room for about sixteen more. When empty, the total weight of the carriage is 66.52 tons, of which 38.65 tons are carried by the three-axle bogie, this weight corresponding to about 12.88 tons per axle. The motor bogie carries 27.87 tons, or 13.93 tons per axle.

200-H.P. DIESEL-ELECTRIC RAILWAY COACH

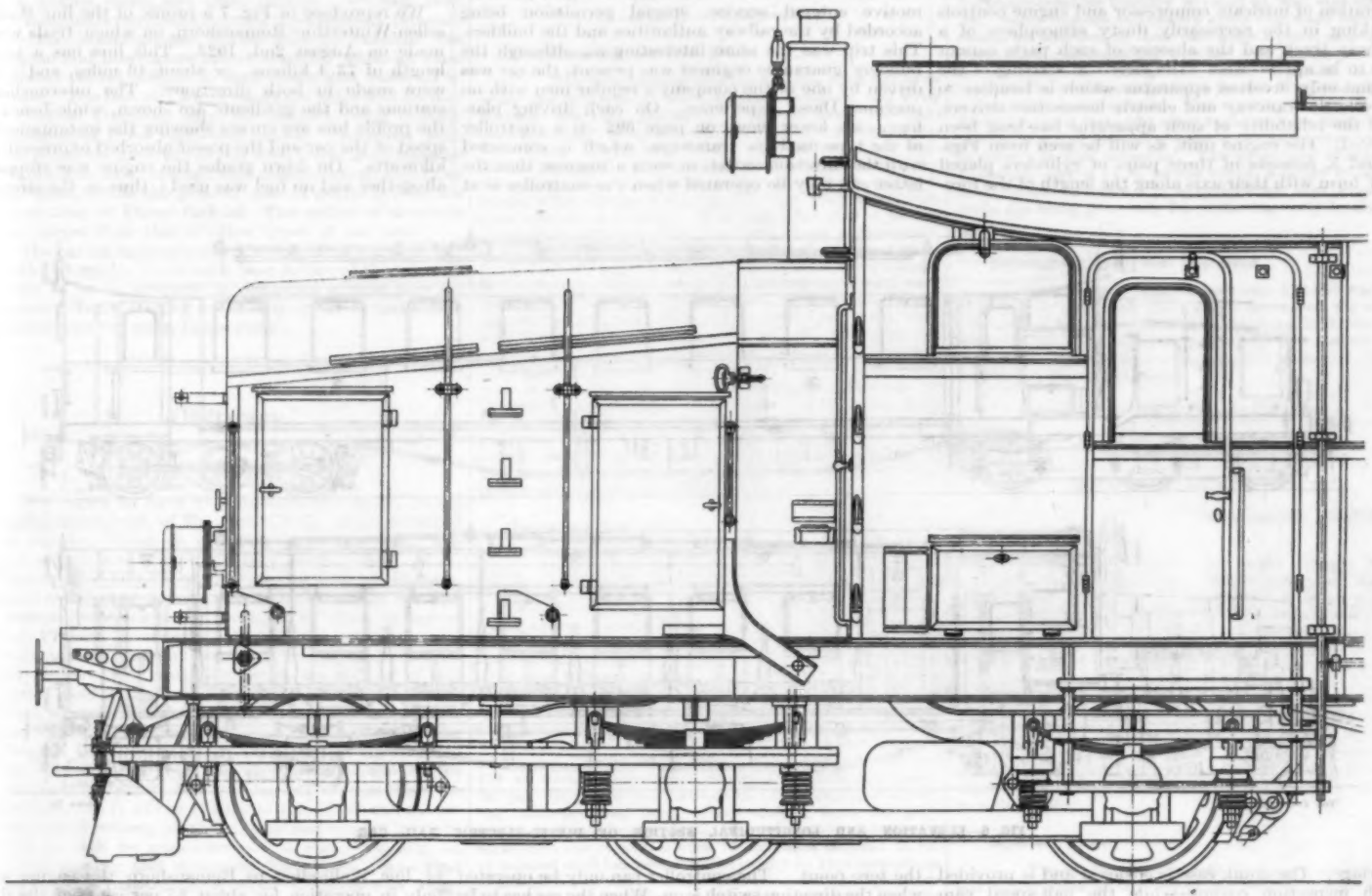


FIG. 5—SIDE AND SECTIONAL ELEVATIONS AT ENGINE END

Engine Details.

We have already referred to the extreme simplicity of the engine as compared with former systems, and when examining the machinery this appeared to us to be the outstanding factor. Experienced Diesel engineers well know the difficulties attending the operation of intricate compressor and engine controls working in the necessarily dusty atmosphere of a railway track and the absence of such parts cannot fail to be appreciated. The electrical starting of the engine only involves apparatus which is familiar to all electric tramway and electric locomotive drivers, and the reliability of such apparatus has long been proved. The engine unit, as will be seen from Figs. 3 and 5, consists of three pairs of cylinders placed in V form with their axis along the length of the fore-carriage. The crank case is enclosed and is provided with inspection covers, while the half-speed cam shaft runs parallel to the crank shaft. Between the cylinders are placed the exhaust silencer and the air inlet manifold, and over them the fuel tank is arranged. The fuel pumps and governor are conveniently grouped at the front of the engine, the control being such that each cylinder may be cut out automatically from the driving cab or controlled by the governor in the ordinary way. When running at 440 revolutions per minute the engine develops 200 horse-power and its design is such that it is capable of giving an output of about 250 horse-power for a short time. When the engine is working under a normal load the power developed is such as enables the car to attain a speed on the level of about 70 kiloms., or 44 miles per hour, or 37 miles per hour when hauling a trailer weighing about 30 tons. The capacity of the fuel tank is sufficient for 500 kiloms., or, say, 310 miles.

Mention may be made of the cooling water system, which is of new design. After leaving the main cylinders, the water passes in a closed system to a series of ribbed coolers arranged along the roof of the car. These are so grouped in combination with a storage reservoir that any desired temperature may be maintained in the circuit by cutting out or putting in cooler units, the range of control being sufficient for either summer or winter conditions. When we were present on a service run, the temperature of the car was maintained at an agreeable degree of warmth by circulating the hot water from the jackets through pipes and radiators on its way to the overhead cooler.

Electrical Equipment.

An outline of the electrical transmission system is shown in diagrammatic form in Fig. 4. The main generator is separately excited, the exciting current being supplied by a special dynamo which is mounted on an extension of the generator shaft. It is an eight-pole machine having a capacity of 140 kilowatts with a terminal voltage of 300, while the exciting dynamo is a six-pole machine which has a constant output of 7.5 kilowatts. An accumulator battery feeds the field winding of the exciter, thereby enabling it to generate its full voltage immediately the engine starts, so that the main generator can be fully loaded without delay. The circuit between the main generator and the driving motors is wired on the Ward-Leonard system, which ensures that no loss of energy takes place, such as would certainly arise were the heavy starting currents passed through starting resistances. This arrangement also renders it possible for the Diesel engine to be run at a constant speed independently of the speed of the car, while the load always corresponds to the most favourable fuel consumption. The driving motors are series wound, and have six main poles and six inter-poles.

Starting and Running.

After undergoing successful trials, the rail car was recently run under service conditions for a period of one month on the Baden Niederglatt section of the Swiss Federal Railways. The facility with which a locomotive is started and stopped can only be fully appreciated by making a footplate run, and this we were able to do on the second day on which the locomotive entered service, special permission being accorded by the railway authorities and the builders. This trip was the more interesting as, although the builders' guarantee engineer was present, the car was driven by one of the company's regular men with no previous Diesel experience. On each driving platform—see lower views on page 692—is a controller of the type used on tramways, which is connected with the direction switch in such a manner that the latter can only be operated when the controller is at the zero point. The controller can only be operated when the direction switch is on. When the car has to be started, the generator—see Fig. 4—is fed with current from the accumulator battery under the car, so that it acts for a short time as a motor and at once starts the Diesel engine. The voltage current and engine speed, also the battery current, are recorded on instruments placed immediately above the controller. During the numerous stops at stations and also on gradients, the Diesel engine never failed to pick up immediately the electric starter was brought into action. When the car is running, the driver is compelled to keep his left hand on the handle of the controller, any release of pressure cutting off the current and opening the brake valve. In order that the brakes may not immediately come into action, a time relay worked through a retarding cylinder ensures that the brake valve does not open until five seconds have elapsed from the time the current is cut off. When the emergency brake is operated the circuit is also broken, so that in all cases when the brakes are on the motors are always without current. In each driving cab the usual Westinghouse air brake is installed, the necessary air pressure being derived from an air compressor driven by the engine. All wheels, with the exception of the middle pair of the forward bogie, are fitted with brakes. In addition to the Westinghouse brake the driver has at his disposal a hand-operated brake, which alone exerts about 35 per cent. of the brake power required to stop the car. The arrangement of the driving cabs and the way in which the controls are operated seemed to combine simplicity of attendance with reliability of working, and the car was quite well driven by one man. The space conditions are, however, such that when the conductor has finished his duties he can quite well take a place beside the driver and render any assistance necessary.

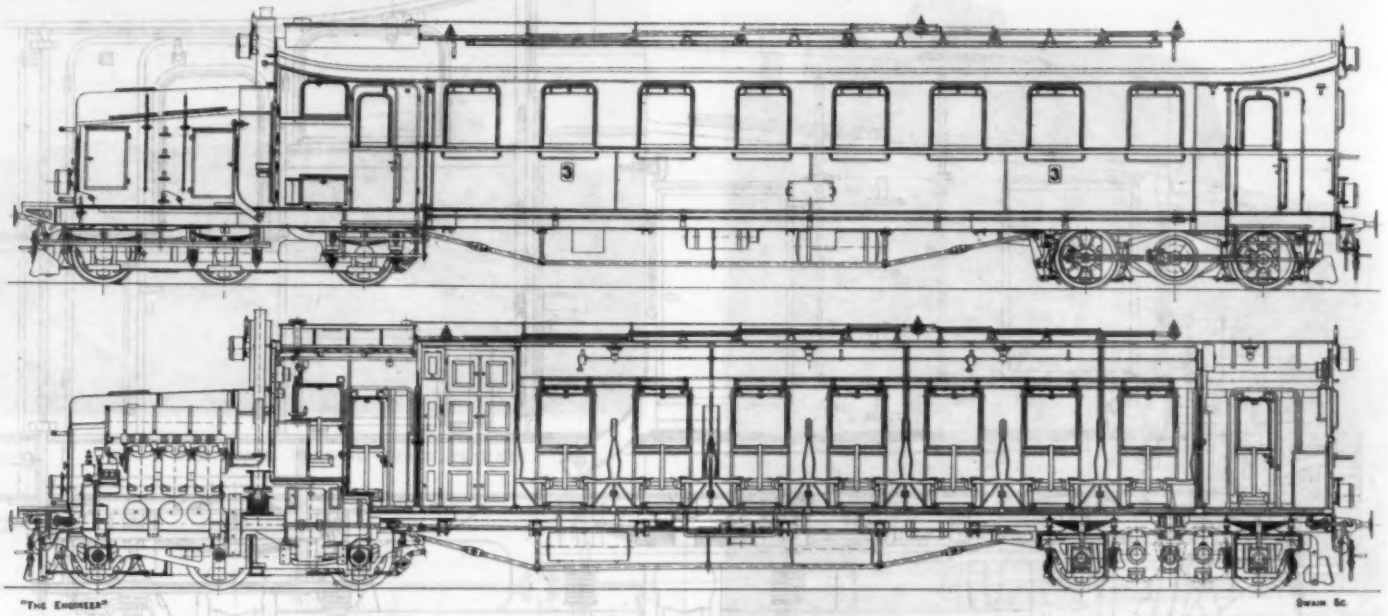


FIG. 6—ELEVATION AND LONGITUDINAL SECTION OF DIESEL-ELECTRIC RAIL CAR

Trial Runs.

We reproduce in Fig. 7 a profile of the line Wallisellen-Winterthur-Romanshorn, on which trials were made on August 2nd, 1922. This line has a total length of 73.4 kiloms., or about 46 miles, and runs were made in both directions. The intermediate stations and the gradients are shown, while beneath the profile line are curves showing the instantaneous speed of the car and the power absorbed expressed in kilowatts. On down grades the engine was stopped altogether and no fuel was used; thus on the stretch of line Wallisellen to Romanshorn the engine was only in operation for about 65 per cent. of the distance, while at other times the load was subject to small and frequent variations. The amount of fuel oil consumed on this particular trial was 84 kilos., or 185 lb., and taking the weight of the car without passengers at 66.52 tons, this gives a consumption of 0.03 lb. of fuel per ton-mile.

On the Baden-Wettingen-Niederglatt section of the line, on which the car has been in regular service for a month, the cost of fuel for a single journey works out at the price of one third-class ticket. The returns for the whole month's working show an average fuel consumption over the period of 0.043 lb. per ton-mile. A remarkable fact concerning the fuel consumption is that it has fallen in the course of the month from 0.047 lb. per ton-mile to 0.040 lb., which must be attributed to the driver having become more adept in the economical use of his engine. In calculating the above figures all fuel used when shunting, re-charging the accumulators and providing compressed air for the brakes is included, while the number of miles run is the total mileage run in actual service.

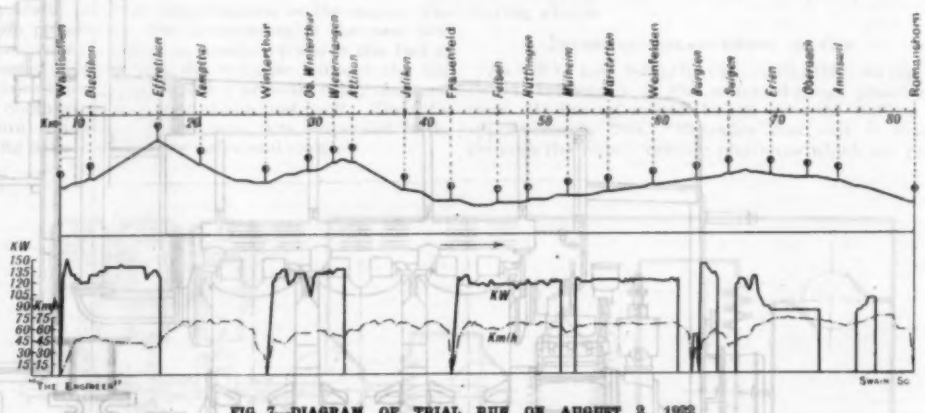


FIG. 7—DIAGRAM OF TRIAL RUN ON AUGUST 2, 1922

General Conclusions.

From what we have already said, it will be recognised that the Diesel-electric rail car is a valuable accessory to the various types of internal combustion locomotives with which our readers are more or less familiar. A significant proof of the interest this car has aroused in Swiss railway circles is the fact that the second car will shortly be put into trial service on the Berne-Neuchâtel section of the Lötschberg railway. It is expected that the rail car will on

branch service show a considerable saving as against the running costs of the ordinary electric train. The economy in fuel is, however, only one factor; an important advantage over the steam locomotive being the absence of stand-by losses and the time saved in the engine sheds and train depôts. Actually only 15 minutes is required to obtain the necessary pressure for the Westinghouse brakes and to examine the engine and lubricators before starting, while an even shorter period suffices to shut down and leave all in order. The fuel and water tanks are large and require periodical attention only, the supplies being quickly replenished from high-level tanks. Compared with the petrol locomotive the fuel used is free from irksome regulations as to storage and manipulation, and from fire risks, while the present cost of petrol is over six times that of Diesel fuel oil. The radius of action is also larger than that of other types of rail cars.

The car we have described is of moderate power, but with the results which have been achieved there would seem to be no obstacle to designing similar cars for heavier trains, leading eventually to the actual Diesel locomotive for main line service.

Obituary.

JAMES RIGG.

WE regret to have to announce the death, in his eighty-third year, of Mr. James Rigg, which occurred at Chorley Wood on the 20th inst. Mr. Rigg was the second son of the late Rev. Arthur Rigg, M.A., Principal of the Diocesan Training College, Chester, At the early age of seventeen he and his elder brother, Arthur, were started in business by their father at the Phœnix Ironworks, Chester, as engineers and ironfounders. About ten years later the partnership was dissolved by mutual consent, the subject of this notice continuing as sole proprietor until the year 1883, when he closed the works and started in practice as a consulting engineer in London. Prior to leaving Chester, Mr. James Rigg designed and constructed the first floating grain elevator to be employed for discharging lighters and loading steamers on the river Danube, but it will be chiefly as a designer and manufacturer of colliery plant for home and foreign markets that he will be remembered. A paper by him on "Coal-tipping and Screening Machinery" was read before the Institution of Civil Engineers in 1896. His fertile inventive faculty found expression in many other directions besides colliery work, and he was also closely connected with the equipment of schools, with the apparatus and appliances necessary for technical instruction. In spite of advancing years he maintained interest in his profession up to the last, and died practically in harness. His wife predeceased him by many years, and he is survived by a son who follows the same profession.

BOOKS RECEIVED.

Aluminium Repairing. By W. H. H. Platt. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 3s. net.

Woollen and Worsted Spinning. By Aldred F. Barker. London: Cassell and Co., Limited, La Belle Sauvage. Price 12s. 6d. net.

Year Book of the Michigan College of Mines, 1921–22; Announcements of Courses, 1922–23. Houghton, Michigan. Published by the College.

Marine Insurance for the Shipper. By Joshua Lea. Manchester: The Manchester Guardian, Limited, Guardian Buildings. Price 1s. net.

Lubrication and Lubricants. By J. H. Hyde. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 2s. 6d. net.

Scottish Canals and Waterways. By Edwin A. Pratt. London: Selway and Blount, Limited, 21, York-buildings, Adelphi, W.C. 2. Price 10s. 6d. net.

Railway Signalling: Automatic. By F. Raynar Wilson. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 2s. 6d. net.

Shield and Compressed Air Tunnelling. By B. H. M. Hewett and S. Johannesson. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 25s. net.

Patent Smokeless and Semi-smokeless Fuels. By J. Arthur Greene and F. Mollwo Perkin. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 3s. net.

Buff Book, October, 1922. Trade and Professional Directory for London. London: The Business Telephone Directories, Limited, 215, Lawrence-lane, Cheapside, E.C. 2. Price, stiff covers, 2s. 6d. each.

The Philadephia Commercial Museum. Pamphlet on International Trade; Foreign Commerce of the United States; The Manufacturing Industries of Philadelphia and the Leading Textile Cities. By John J. Macfarlane.

Standard Handbook for Electrical Engineers. Prepared by a staff of specialists. By F. F. Fowle. Fifth edition. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 30s. net.

The Law Relating to Electrical Energy in India, being the Indian Electricity Act, 1910, Act IX. of 1910. Second edition, revised throughout. By J. W. Meares. Calcutta: Thacker, Spink and Co., P.O. Box 54. Price 24s. net.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Christmas and the Iron Trade.

THE Birmingham iron market this week has been under the influence of the Christmas holidays, and little business has been transacted. Buyers have, however, been sounding the market with a view to business in the New Year. There was an air of some returning confidence present at the weekly market to-day—Thursday—though the attendance was small. Consumers and producers alike expressed the opinion that 1923 opens with some amount of promise. It is concluded that if we are saved fresh labour troubles there will be an improvement in the key industries of manufactured iron, coal and steel. In the last four months there has been a slow improvement in the principal manufacturing industries associated with Birmingham and the Black Country. Conditions in the engineering and brass trades are to-day better than they were a year ago, though hardly any of the works are running full. It is considered favourable that the bulk of the engineering firms which usually close down for a full week at Christmas are this year resuming operations on Thursday. Consumers of materials of most descriptions are now finding it necessary to consider their stocks position. Some of them have lately undertaken a certain amount of buying as a precaution against high prices. The general outlook is such that any lower prices than now prevail are regarded as unlikely.

Improving Steel Prices.

In the finished steel trade business has improved, partly owing to the increased demands of shipbuilders, and to some extent this has affected the trade of this district, although the bulk of the material will be produced in the Middlesbrough or Barrow-in-Furness areas. Keen competition from South Wales plate mills has lowered ship, bridge and tank plates to a price which some producers will not look at. Small steel bars are selling on rather less restricted lines, and prices have appreciated 5s. per ton. District makers quote £9, and Lancashire houses want £9 5s. for delivery in South Staffordshire. The latter figure is, however, in excess of the ideas of consumers. Staffordshire hoops, which are now rated at £11 at works, show some movement. They are about 5s. per ton under the Lancashire price, and monopolise the business going here. The re-rolling firms are very busy, one well-known local concern having introduced additional power with a view to increased output. A lot of finished steel has been booked locally by representatives of South Wales steel works. There is a better inquiry for steel strip, which is not so plentiful as it was, and the price is hardening. Values range from £10 15s. to £11. Much of this material has been booked within the last fortnight, and in view of the comparative absence of continental competition, the steel works have secured their highest price without much difficulty. Billets were this week quoted at the rates to which they recently advanced, viz., £7 5s. to £7 7s. 6d. upwards. It was stated, however, that business had been done at a lower figure. No change has occurred in steel wire values, but if anything, the volume of orders has increased, and the mills look like having a busy time.

Manufactured Iron Situation.

The Staffordshire ironworks are more active, and demand continues to improve, the recent shipbuilding orders having made demands upon the rolling mills for the production of chain and anchor-making iron, while the wagon-building works have also taken fair quantities, especially of marked bars and best iron generally. The marked bar mills are well employed. Warehouse stocks of merchant bars are being gradually replenished. The general view has been that £10 15s. represented the minimum for merchant or Crown bars, but orders have in certain cases been accepted as low as £10 7s. 6d. The makers are now adopting a firmer attitude in view of the improved demand, the advance in scrap prices and the rise in ironworkers' wages; while coal is rather dearer than it was. There is quite a good demand for scrap, which is selling as high as £4 per ton. The Staffordshire ironmaster also has to face the prospects of higher prices for pig iron, which smelters are determined to obtain at the earliest opportunity. Nut and bolt makers are receiving stronger support. Measuring the prospects of the raw material market, they are disposed to fortify themselves with rather larger supplies of bars. British makers are in a more favourable position to respond promptly to any buying movement than are their competitors on the Continent, and both Staffordshire and Lancashire houses are booking somewhat better business round about £9 15s. Only in exceptional cases is the £9 15s. basis shaded by Staffordshire makers, and Lancashire houses that compete on this market affirm that it is irreducible, and they ask half-a-crown extra for fencing iron. Sellers are not inclined to commit themselves beyond January delivery, though they have been sounded as to contracts running on to April. Brisk business is being done in black sheets, partly to feed the galvanising works and with a good proportion going to be utilised for motor building. Galvanised sheets are still a good stand-by, at a minimum of £17 5s. There is a good deal of inquiry from the Colonies.

Pig Iron.

Pig iron maintains its position, and a little more business in the foundry branch inspires hopes of better things next year. Some smelters say they could sell more than they are now producing, but before setting additional furnaces into commission they want to see how the present incipient movement develops. With present high production costs makers will not risk the heavy outlay of capital that would be involved in producing iron for stock, preferring to keep outlay strictly within limits. Forge iron is still to a large extent neglected, a lot of cheap steel still being reheated and re-rolled into bars. There is evidence of this in the state of the puddling industry, dozens of furnaces having been idle for at least a couple of years. Prices have not wavered during the week. For Derbyshire No. 3 foundry 82s. 6d. at furnaces is a firm price, and for forge 72s. 6d. to 75s. is asked. Northamptonshire foundry is rated at 80s. and forge at 70s. Some furnace owners are again this week seeking to obtain an addition to their last week's price, and several Derbyshire makers of pig who are well placed are asking 2s. 6d. above the recognised basis. Business does not appear to be forthcoming at this figure. The coke position is becoming quite serious. The scarcity is so great that during the past fortnight some furnaces have been obliged to burn raw coal instead of coke, a practice never resorted to except in dire necessity. The price now charged for Yorkshire coke is £1 3s. at the ovens, a figure which cuts down profits severely. It is understood that some coke ovens are being got ready for restarting early in the New Year.

Birmingham Tube Mill Destroyed.

Damage estimated to approach £10,000 was done by a fire on December 21st, which destroyed the copper tube mill of Messrs. C. M. Powell Brothers, of Aston-road, Birmingham. The mill was completely demolished, being burned out from floor to roof, only the walls and charred rafters and beams remaining.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THERE have been very small changes in the iron and metal markets since we last wrote, and but few opportunities for them, because most of those engaged in the trade have been making holiday. As the year closes, however, all the markets have a stronger appearance, which may possibly indicate that we are at the end of a long depression. That there will be any very rapid revival in trade next year is, of course, improbable, and it would no doubt be foolish to build upon any such expectation; but for all that, there may be reason to believe that business in the New Year will be better than it was in the old year. This is not saying very much, because it is generally admitted that so far as ordinary engineering business is concerned the year now ending has been about as bad as it could be.

Metals.

The slight improvement in copper prices which has taken place at the end of the year is mainly caused by optimistic reports from America, and does not seem to be sustained by any increase in the actual consumption of copper on this side. The slight rise, however, has induced some British consumers to buy with a little more freedom, and probably the opinion is growing amongst copper consumers that the very low prices seen this year are likely to prove the lowest for some time. Confidence of this kind always leads to an increase in the tonnage of copper held by the consumer, and this makes it easier for the producer to maintain or to raise his prices. In America the return of prosperity to the brass trade is a point to be noted. It is said that the brass makers are now working to nearly the full extent of their capacity. Our brass trade is, of course, hampered by the excessive prices demanded for manufactured brass, and these prices are excessive partly because the mills are not working to the full extent of their capacity. The rise in refined ingot copper since the middle of December is about £3 per ton in electrolytic, and £2 per ton in best selected, and it seems quite possible that this is the beginning of a permanent improvement in refined copper prices. At the beginning of 1922 these prices were just £2 per ton higher than they were at the end of the year, but by February they had fallen to the lowest prices seen for raw copper since the advance caused by the war, viz., £58 for standard, £61 for best select, and £63 for electrolytic. It will be seen that during the year now ending some recovery from the depression in copper prices has been made, and this should give hopes that the worst has now been seen. The only reason for supposing that progress in the upward move in prices may be checked is that American output is increasing and may possibly be developed too fast for the needs of world trade. The market for tin has fluctuated a little, but there has not been much movement since I last wrote. The spot price of standard tin went over £180 again, but whether this means higher prices in the New Year one cannot say. All that can be said in this connection is that there appears to be a belief in the London market of higher prices. The market seems to be entirely at the mercy of manipulators and speculators; and, of course, the persistent rumours of higher prices may be merely a manœuvre in the speculative game which is being played. As the year closes lead is a very strong market, and the last prices quoted are the highest seen during the course of 1922. Spelter is not quite so firm as it was, and the backwardation of £3 per ton on forward metal is rather a disconcerting feature.

Pig Iron.

The close of the year finds the market for pig iron quite steady in Manchester, but, of course, there is very little actual business going on this week. There is to be only one market meeting on the Exchange, viz., on Friday, and no particular business can be expected; but for all that, one finds quite a cheerful feeling about; and there is no doubt that the ironfounders of this district are better off for work than they were six months ago. As to any serious advance in the prices for pig iron, this is very improbable, for more furnaces are being put into blast, and it may be doubted whether the demand for foundry iron is growing quite so fast as the supply. A matter of particular interest to the Manchester ironfounder is that the furnaces of the North Lincolnshire group are to be started early in the New Year. This iron has always been

a favourite with some Lancashire founders, and it has not been in the market since the great coal strike of 1921. Its re-appearance in the Manchester market will, of course, tend to prevent any rise in the price of Derbyshire iron, if such has been contemplated. Scotch No. 3 iron remains very firm in Manchester, and for the good brands, such as "Summerlee," £5 12s. 6d. per ton delivered is now asked.

Steel.

The tendency in the market for manufactured steel is towards slightly higher prices, but it is difficult to gauge the market this week in the absence of business. A good deal of confidence is, however, expressed as to the conditions of trade next year, and a much larger business is expected, which may perhaps enable the makers to get back to profitable prices.

Scrap.

No great business is heard of in scrap this week, but the market is decidedly stronger than it was. The demand for steel scrap seems to have put heart into the dealers, and they are now asking 62s. 6d. per ton on trucks in this district. Sheffield is a better buyer, and in South Wales up to 82s. 6d. has been paid. Heavy wrought scrap is firmer at 70s. to 72s. 6d. per ton delivered, and dealers in cast scrap are not nearly so weak as they were. Those who have broken textile machinery metal to offer—and there are not many of them—quote 87s. 6d. per ton, and from 82s. 6d. to 83s. 6d. is quoted for ordinary broken machinery metal.

Barrow-in-Furness, Thursday.

Hematite.

The position in the hematite pig iron trade is one of substantial prospects. There seems to be no doubt now but that the revival much anticipated has arrived, and that from now, unless labour troubles in the coal trade disturb the whole business, we may expect good trade. The Continent is taking considerable deliveries, and this trade may further improve. Cargoes continue to go to America. There was dispatched last week from Barrow another consignment for Baltimore. There are some people who hope that the American trade will continue, and it is possible that deliveries will be made, but not in the bulk as of late. Italy is not a customer yet, but there are hopes of trade with that country developing shortly. Special sorts are finding customers. Several cargoes of pig iron have left Barrow for Liverpool for transhipment.

Iron Ore.

The iron ore trade is better, and will continue to improve as the furnaces in blast increase in number. Prospects are fairly good, but there is not a great quantity leaving the district. The amount of foreign ore which was in stock has been reduced, but imports are not heavy yet by any means.

Steel.

The Barrow rail mills are at work and likely to be for a month or so on present orders, and before these are completed it is hoped there will be more business booked. Workington rail mills are idle, but hopes for a re-start in January are indulged in. The Barrow hoop mills are partially engaged, and foundries are experiencing better business.

Shipbuilding and Engineering.

There is little to report of the shipbuilding and engineering trades, but the prospects are improving daily, and there may be news of more work shortly.

SHEFFIELD.

(From our own Correspondent.)

The Busy Steel Furnaces.

Sheffield has to a large extent rested during the past week, and in the majority of cases the works will not resume until after New Year's Day. That, however, is due solely to the Christmas holiday, and not to any falling off of work. The progress towards a general revival is maintained, especially in the heavy steel departments, which continue to book more and more orders, and are looking forward to an active resumption of operations. The furnaces expect to be very busy, especially those, not only in Sheffield and district but also in Lincolnshire, which turn out basic steel. Their production has recently shown great increases, and they are well booked for the opening of the New Year. The better quality acid steel, too, is in much improved demand. Prices are very firmly held, and show a tendency to harden further. Soft basic billets, which not long ago could be bought for £7, are now by no means easy to secure at £7 15s. The blast-furnaces and steel furnaces are consuming an increasing quantity of scrap, which is consequently a very strong market.

Other Heavy Branches.

The year closes with active conditions at most of the rolling mills, and with an improving state of things at the steel foundries and forges, the position of which had been very unsatisfactory for a considerable time. The railway steel branch continues to secure more business, and fully retains its confidence in the near future. The requirements of the home railway companies are sure to be heavy, and makers of axles, tires, and springs can see a good weight of business on the way. There is also a better outlook for trade with the South American railways. An increased number of orders is on hand for locomotive forgings, tubes, and castings. The wagon departments are sharing in the increased activity, and this is benefiting Rotherham, where a good deal of the trade is centred. It is believed that builders are in for much better times than have prevailed for several years. One of the firms enjoying an improvement is Harrison and Camm, Limited, of the Holmes, and it is stated that they are likely to be fully employed during the whole of the coming year.

How the Pits are Helping.

There is a very good demand for industrial fuel, and no great surplus of supplies. The Yorkshire pits are working extremely well, and some figures of output have lately been published which are of much interest, especially in view of Mr. Charles Markham's statement that it would not require much of a boom in trade to cause a scarcity of coal, owing to the limited amount of sinking that has been done during the last eight years. Some of the big pits in the Doncaster area are turning out remarkable quantities of coal. Brodsworth Main, in a recent week of 5½ days, or approximately seventy-four hours, had an output of 27,529 tons, the greatest quantity brought to the surface on one day being 5550½ tons in thirteen hours' winding. In the same week Bentley colliery turned out more than 25,000 tons, while Yorkshire Main beat its previous best with 23,200 tons, which is said to be a record for a pit the depth of which exceeds 900 yards. In West Yorkshire, too, records are being beaten. For the week ending on December 20th, the Glass Houghton and Castleford collieries turned out 22,456¾ tons, including the remarkable quantity of 5593 tons drawn on one day.

The Lighter Trades.

The lighter branches of the steel industry are not yet benefiting much by the improved state of trade generally, and some of them are still in a poor way. There is some improvement in the demand for crucible steel, but little is being done in high-speed steels, Government stocks of which are not yet exhausted. Engineers' small tools made of high-speed steel are in poor request. As to other classes of tools, the prospects are better, especially as regards trade with the colonial markets, which are showing some life after a period of comparative stagnation. The cutlery and electro-plate trades finished the year well, having enjoyed much activity during the last few weeks. Most of the firms have now worked off the bulk of their orders, but the outlook is considered fairly good. In the case of electro-plate, several houses have already booked a fair amount of business for the New Year, and there is a number of export inquiries for the best classes of goods, which should result in substantial orders. The stainless table knife branch continues to be best feature of the cutlery trade, but the amount of business on hand at present is not very large. Neither is much new work coming forward in the spring knife section. A fair amount of work is being done in the production of safety razor blades.

A Continental Acquisition.

The news that Vickers Limited have acquired a large holding in the Resitza Company of Roumania is of much interest to Sheffield. The Resitza Company owns one of the largest steel works in what was pre-war Austria-Hungary, but is now in Roumanian territory. A few months ago Messrs. Vickers bought 25 per cent. of the capital of the company, and now they have arranged to take up 30 per cent. of a new issue of shares, which will soon be put on the market. The openings for the steel trade in Roumania, given a restoration of satisfactory financial conditions, are, of course, immense. There is, in particular, a great need for the reconstruction of the transport system of the country. The effect of the new arrangement on employment at Messrs. Vickers' works in Sheffield and other parts of this country is not easy to gauge, but it is bound to give the firm an advantageous position with regard to trade in Roumania and in Eastern Europe generally. While such trade will in the main be done on the spot, it is only natural to expect that in busy times some of it will come to this country, and that any branches of work for which Messrs. Vickers may be better equipped than their Roumanian partners will be sent over here for execution.

Forty Years in Sheffield Trade.

Mr. Frederick Best, secretary and director of Thomas Firth and Sons, Limited, who leaves at the end of this year to take up the post of commercial manager of Bolckow, Vaughan and Co., has been the recipient of presentations from his fellow directors of Firth's, and also from the members of the staff. Mr. Best has completed forty years' work in the Sheffield steel trades, having served for twelve years with William Jessop and Sons before joining Firth's, with whom he has been for the past twenty-eight years.

A New Dock Scheme.

Among the proposals for public improvements which are being put forward at the present time, largely with a view to finding work for the unemployed, one of the most important is the suggestion that a new fish dock should be constructed at Grimsby. The importance of this development is being urged by the Councils of both Grimsby and Cleethorpes, which are in negotiation with the Great Central Railway Company with regard to it. At a meeting of the Cleethorpes Council last week, it appeared that the railway company has offered that, if the two local authorities will make themselves responsible for the erection of the outer wall of the dock, which will cost a quarter of a million, the Great Central will carry out the remainder of the work, including the fish dock extension scheme. The Cleethorpes Council approved of this proposal. Application will be made to the Unemployment Grants Committee for a substantial contribution towards the cost of the work.

Other Public Schemes.

There are several other public utility schemes afoot; in fact, hardly a week passes without a number coming to the fore. The Derbyshire Education Committee is anxious to embark on an expenditure of £107,000 for the building of seven new schools and the alteration of various elementary and higher-grade schools, and the Board of Education has been asked to sanction the expenditure. Chesterfield is proposing a sewage works extension, which will involve the making of a new main outfall at Whittington, somewhat further down the river Rother than the present outfall. The full cost will be £25,000, and a Ministry of Health inquiry has been held into an application for sanction to the borrowing of £19,625 for the main portion of the scheme. Much dissatisfaction is expressed at Mexborough at the refusal of the Ministry of Health to authorise the building of further houses under the State-aided scheme. The Council desires to build thirty-three more houses, and it is asking the Ministry to receive a deputation on the subject of the town's housing needs. The Adwick-le-Street Urban Council recently sent a deputation on the same subject, with the result that the Ministry offered to allow twelve additional houses to be built under subsidy if the Council would build double that number without assistance as soon as economic conditions allowed them to do so without burdening the rates. This offer has been accepted.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Disastrous Year.

No one interested in the industrial prosperity of the North of England will mourn the passing of the year 1922. Looking back over the twelve months, there is revealed one long story of hope deferred, of constant struggle against adverse circumstances, and at the end just a limited amount of success in the ceaseless efforts to restore activity. The year, indeed, has been crowded with bitter experiences for all associated with industry, whether in control or as a humble unit amongst the great army whose livelihood depends upon its prosperity. The iron and steel trade—the staple industry of this important area—has passed through many vicissitudes during its long history, but never has it suffered such a disastrous time as that experienced during the past twelve months. Whilst the national output of steel during 1922 shows a respectable advance upon that recorded in 1921, the North-East Coast has produced less steel during the past twelve months than in 1921, in spite of the fact that in 1921 three months' output was lost through the miners' strike. In 1921 the steel produced on the North-East Coast amounted to 991,500 tons, representing 29 per cent. of the total British output, whereas in the year just closing the production has been about 830,000 tons, representing about 27 per cent. No other district, with the possible exception of Sheffield, has been so seriously hit, and in a great measure the decline in the steel output is directly attributable to the stagnation in the shipbuilding trade, with the consequent stoppage of orders for material. The local output of pig iron for 1922 is expected to be about 1,455,000 tons, which represents about 30 per cent. of the total production of Great Britain. These figures show a substantial advance compared with those of the previous year, the improvement being largely due to the fact that during 1922 there has been no such interruption to production as was occasioned by the coal strike of 1921, which caused a stoppage of the ironworks for nearly four months.

A Brighter Era.

There is now discernible, however, a distinctly brighter horizon. A spirit of optimism, restrained perhaps, but none the less clear, prevails regarding future trade prospects. The shipbuilding industry is emerging from what has probably been the gravest crisis in its history with corresponding advantage to the iron and steel works, and the Government projects for the relief of unemployment should result in giving an impetus to trade. There are, however, many difficulties still to be faced, and not the least of them is the high costs of production. The high cost of fuel is a serious matter. No relief was afforded during the past year. Indeed, having regard to the cheaper transport charges, the ironmaster is now actually paying more to the coke maker than he was at the beginning of 1922.

The Holidays.

The holidays have more or less dislocated industry in the North of England, and things will not really settle down again until next week has passed. At the various steel works advantage is being taken of the holiday to carry out necessary repairs, and in most cases the mills will be at a standstill until Wednesday next. In the shipyards, where there are signs of the trade revival, the general holiday is limited to two days in each week.

Cleveland Iron Trade.

There is no change to note in the general condition of the Cleveland pig iron trade. Business has practically ceased until after the holidays. The outlook, however, continues to improve. Heavy buying of pig iron in America and a rise of prices over there reopens the prospect of renewed business in Cleveland iron with the United States. Of course, shipments under existing contracts still continue, and if no more orders were booked these shipments would not cease for another three months. Prices are steady, No. 1 and siliceous iron being 95s.; No. 3 G.M.B. Cleveland, 91s.; No. 4 foundry, 85s.; No. 4 forge, 82s. 6d.; and mottled and white, 80s.

Hematite Pig Iron.

The East Coast hematite pig iron trade is in a fairly satisfactory condition. Makers are well situated with orders and the present output is being fully taken up. Mixed numbers are still quoted at 93s., with 6d. per ton premium asked for No. 1 quality.

Iron-making Materials.

The imports of foreign ore continue on a heavy scale, but little new business is being placed. Although there has been a fall in freight rates, sellers still ask 22s. 6d. per ton for best Rubio ore c.i.f. Tees. Blast-furnace coke is firm at 29s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trade continues to show a distinct and welcome improvement, and the outlook is encouraging. Specifications for shipbuilding material are coming forward in increasing volume, and there is an all-round better demand for other constructional steel. Prices are firmly maintained.

The Coal Trade.

The tone of the Northern coal market generally is not so firm as it was, but the position is in some respects irregular and erratic, varying considerably according to the individual position of the producers. The prompt market is more or less quiet and devoid of special interest, only odd transactions for spot being recorded. There is a fair number of inquiries in the market for both the first quarter of next year and for later periods, but for the most part buyers are inclined to hold off a little while longer in the hope of being able to do better later on. Northumberland steam coals are quiet and rather easier, with the solitary exception of best steam smalls, which are very scarce and quoted at higher rates. The Durham gas coal trade is much more stable and reliable, and, judged by the prices ruling, the position is steady and the outlook fairly satisfactory. Bunker coals are quite strong for early forward. All makes of coke are in good demand, and prices are steady for well into next year.

SCOTLAND.

(From our own Correspondent.)

No Regrets.

IN an industrial sense, at any rate, the passing of the year 1922 will occasion no regrets. In almost all trades the past twelve months have been one of the worst periods on record in respect of unemployment and distress. Under the circumstances it is worthy of note that this period has passed without any untoward occurrences worth mentioning in spite of a strong undercurrent of revolutionary influence. It would appear as though the minds of the workers have at last grasped the fact that the natural sequel to ca' canny methods is low wages and unemployment. If such be the case the future is indeed hopeful. In conversation with many workers the writer has been impressed by their realisation of the folly of strikes, ca' canny, and other methods of a reactionary nature, and there seems ample evidence that the poverty of the year 1922, one of the direct outcomes of such methods, is bearing fruit.

The Turn of the Tide.

Once again it can be said that the outlook for a new year is full of hope. For weeks past the accumulation of shipbuilding orders has been mentioned and the movement is continued. The effect of this on allied trades is now being felt, and producers are busy making ready for an anticipated return to old-time activities. Also, the schemes on hand to relieve unemployment will be a boon in many respects to the affected areas. Apart from the railway proposals, the new roads in prospect will be of immense benefit to traders in Scotland, while hope is still entertained that the Mid-Scotland Ship Canal scheme will also be sanctioned. Works are being fully equipped and added to, shipyards put into full commission, and improvements in dock arrangements are being considered in all areas interested. The revival may be slow, but nevertheless the outlook for 1923 is distinctly hopeful.

Steel and Iron.

A change for the better has been noticeable in the steel and iron trades during the past week. Inquiries are broadening out on all sides, and consumers show more inclination to anticipate their requirements. Cheaper railway rates and the decline in foreign competition are partly responsible for the improvement in the local situation. Producers are now in a better position than the foreigner to give urgent deliveries, while home prices are now nearer a competitive basis. At the moment steel makers have better inquiries for plates, while sheet makers are now in a better position than during the greater part of the year. Home demands show a decided increase, while formerly export orders were practically the sole source of business. Galvanised sheets also are showing a good turnover. The bar iron mills have better employment, and the re-rolled steel department is fairly active. Though pig iron continues quiet, the improvement in the consuming trades has created a stronger feeling in the market. Prices are firmly maintained all round, and there is a harder tendency apparent in steel, though additions to quotations are not immediately looked for.

Coal.

Conditions in the Scotch coal trade have not changed during the week. With the collieries being heavily sold as regards round coal and treble nuts, new business in these has been of little account. Small lots have been available in some instances where holders have offered easier prices in order to reduce stocks. Double nuts have shown a fair turnover, but single nuts, pearls and drosses are very poorly bought. More steamers have arrived, and the congestion at the ports in Fifeshire and the Lothians is being gradually relieved. Home demands are restricted, and there has been an entire absence of the rush usually met with at this season of the year. Quotations are inclined to ease a trifle.

Opening Up in Lothians.

Messrs. William Baird and Co., coalmasters, have purchased an estate at Armadale, West Lothian. This purchase was made in order to secure coal in the lower measures. The same proprietors also recently took over coalfields in Bathgate owned by Messrs. Gavin, Paul and Sons, Edinburgh, and from their Hopetown Collieries in Bathgate are entering on an extensive scheme to open up seams in and around Bathgate and Armadale.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE year has closed with the conditions prevailing in the steam coal trade better than they were at one time expected to be, and the prospects for the New Year are very satisfactory, and are enhanced by the decision of the Miners' Conference to postpone action regarding the wage question until the reassembly of Parliament, and a further report has been received from their executive respecting the attitude of the Government. It is to be hoped that the New Year will not see a determination on the part of the workmen's leaders to adopt any drastic action just at a time when the coal trade gives every promise of entering upon a period of comparative prosperity. Business has already been done for a fair amount of coals for shipment to the northern range of ports of America, and hopes are entertained of shipments being on a considerable scale to Canadian ports when the St. Lawrence River reopens for navigation. It is difficult to say to what extent the operations run in respect of coals for America, but there is a very good inquiry for supplies over various periods of next year. At the moment some of the inquiries have rather a speculative appearance, and, therefore, it is hard to say whether they will materialise into actual business. The view generally held is that next month will undoubtedly see the market firm, although it is extraordinary how quickly the conditions alter and are affected by some unforeseen developments in respect of tonnage supplies, &c. Unquestionably the demand from the States is occasioned by the fears that there will be a recurrence of labour troubles at the American bituminous collieries at the end of March. Mr. H. H. Merrett, of the firm of Llewellyn, Merrett and Price, Limited, of Cardiff, who has just returned from the States, has expressed the opinion that there is very little possibility of averting a stoppage, as no progress has been made towards a settlement; neither has there been any progress in the matter of the formation of a committee to consider the prospects of a settlement. It is generally recognised in the States that the fight has yet to come. This being the case, there is every prospect of considerable quantities of coals being required from this country, and, further, the markets which have been supplied by the Americans will undoubtedly look to the United Kingdom to cover their requirements. The Brazil Central Railways are now inviting tenders for 150,000 tons of best quality Welsh coals in the proportion of two-thirds large and one-third small, for delivery over the first six months of 1923, and recently the Navagazione Generale Italiene is reported to have purchased 60,000 tons of Welsh steam coal for delivery over the same period. As a matter of fact, there are more orders now in the market for cargoes for shipment to Italy next month than has been the case for several weeks.

Third Shift Fight.

As pointed out some time ago, there is to be a stiff fight over the question of the adoption of a third shift at the docks. The Cardiff Chamber of Commerce has called a special meeting to discuss the matter on Friday of this week. Immediately prior to the holidays the delays in the loading and sailing of tonnage were greatly intensified by the bad weather, which adversely affected the movement of steamers and resulted in the temporary stoppage of some collieries. On Thursday of this week there will also be a meeting of the South Wales Area Board, which consists of representatives of the shipowners and coal trimmers, and controls the trimming arrangements of the ports. It is understood that immediately after this meeting the coal trimmers intend publishing their case against the adoption of the third shift. No doubt it will be much on the lines of the statement issued by the officials of the Transport and General Workers' Union of Newport, wherein it is contended that the congestion is due to a variety of causes, such as waiting for coal from the collieries, waiting for ships, the delay in the movement of ships when in dock, running repairs, &c., as well as factors over which no one has any control. There is no doubt that there is need for more elasticity in the working conditions at the docks, as instanced by the case of the steamer Byeway, of about 5000 tons, which last week was loading a cargo for the River Plate, and at mid-day on Saturday required a few hundred tons to complete her cargo. The coal was all ready, and a matter of a few more hours' work would have meant the finishing of the loading, thus enabling the steamer to get away before the holidays Application was made by the owners to the Great Western Railway Company, whose officials were willing that work should be continued as long as was necessary, and application was also made to the coal trimmers to work the extra time. The owners were willing to pay any charge that the trimmers thought fit, but the men absolutely declined to work on Saturday afternoon, with the consequence that the steamer was detained over the holidays until Wednesday in order to complete taking in a few hundred tons of coal to finish the cargo.

Colliery Development.

It is reported that a splendid seam of bituminous coal has been struck at Mynydd Bach-y-glo, near Cockett. Mr. David Samuel, mining expert, commenced sinking operations a few weeks ago after several unsuccessful attempts, and struck the seam near the surface, which proved that there is a large area of virgin coal in the district. The official announcement is made that the Lower Duffryn Colliery, Cwmpenner, Mountain Ash, was to be opened on the 27th inst. This colliery was closed down about six months ago, but in the interval extensive alterations have been carried out.

Current Business.

There was practically a suspension of business during the second half of last week, and it is very improbable that much will be done until next week. There has been a fair amount of inquiry, but as colliery salesmen had made arrangements for the whole of their output up to the end of this year and the early part of January, they were very reluctant to accept any fresh obligations until they see what the conditions are like after the holidays, as they are firmly of the opinion that the market will be very firm. All last week there was a rush to get tonnage loaded and dispatched before the vacation, and a good number of steamers were completed, but, on the other hand, many were unsuccessful, and there is a good supply of tonnage still in dock on which loading operations were resumed on Wednesday, while in addition a fairly considerable number of boats put in an appearance during the holidays. For the time being prices are nominal on the lines of those of a week ago.

Catalogues.

RUBERY, OWEN AND CO., Darlaston, South Staffs.—Catalogue of the firm's structural department.

WERKSPOOR, Amsterdam.—An illustrated brochure giving full particulars of this firm's marine Diesel engines.

JOSEPH ADAMSON AND CO., Hyde, Cheshire.—Illustrated leaflet on electric blocks for industrial purposes.

BRITISH THOMSON-HOUSTON COMPANY, Limited, Rugby.—Illustrated pamphlet on electric drive in textile mills.

BROWN BROTHERS, Limited, Great Eastern-street, E.C. 2.—A copy of the August-September issue of the *Accessory*.

RANSOME AND MARLES BEARING COMPANY, Limited, Newark-on-Trent.—Catalogue of R. and M. ball and roller bearings.

ANDREW BARCLAY, SONS AND CO., Limited, Caledonia Works, Kilmarnock.—Illustrated brochure on locomotives for gasworks.

THE CAMBRIDGE AND PAUL INSTRUMENT COMPANY, LIMITED.—New catalogue dealing with the firm's electrical CO_2 instruments.

RUDGE-WHITWORTH, Limited, Coventry.—Pamphlet by Mr. H. L. Heathcote on the Rudge-Whitworth research laboratories, 1901–1922.

THE PATERSON ENGINEERING COMPANY, Limited, Windsor House, Kingsway, W.C. 2.—Pamphlet on chemical treatment of condensing water.

SAMUEL OSBORN AND CO., Limited, Clyde Steel Works, Sheffield.—Pamphlet No. 4 contains a description, with illustrations, of Osborn's "Mushet" steels and tools.

THE NORTHAMPTON POLYTECHNIC INSTITUTE, St. John-street, E.C.—The annual book containing educational and social arrangements made for the season 1922–23.

BRITISH INSULATED AND HELSBY CABLES, Limited, Helsby, near Warrington.—This firm has sent us a comprehensive catalogue on aerials and aerial fittings. Particulars are given of aerial poles, pulleys, insulators, lead in tubes, &c.

CHARLES ERITH AND CO., Palace Chambers, Bridge-street, Westminster, S.W. 1.—A catalogue has been forwarded to us from this firm on Riley stokers. Besides describing the principle on which these stokers work, the publication deals with the general construction and the advantages which the makers claim.

NATIONAL BOILER AND GENERAL INSURANCE COMPANY, Limited, Manchester.—Illustrated catalogue of tools and instruments. The articles included in this catalogue are such as are used by the company's inspecting engineers in the course of their work or have otherwise been tried and proved suitable for the purpose for which they are offered.

GLASGOW ELECTRICAL ENGINEERING COMPANY, Limited, 45/47, Pitt-street, Glasgow.—"Natural Power from the Wind" is the title of a neat little booklet which has been forwarded to us by this firm. The booklet deals with wind power installations for generating electricity. Particulars and prices are given for three different installations. Some interesting particulars and illustrations of the masts and other parts of the installations are also given.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

GLENFIELD AND KENNEDY, Limited, of Kilmarnock, asks us to state that their offices will be closed on Monday and Tuesday, January 1st and 2nd, and their works from Monday to Wednesday inclusive, January 1st to 3rd.

MR. WM. MATTHEWS, M. Inst. C.E., asks us to state that on December 31st he is vacating his office at 39, Victoria-street, Westminster, S.W. 1, and requests that all communications should, after that date, be addressed to him at 58, Westwood-road, Southampton.

WE learn with regret of the death of Mr. J. A. Hill, late principal of the firm of Messrs. J. and P. Hill, of Ordnance Works, Sheffield, which occurred on December 12th. We are informed that the business will be carried on under the direction of Mr. Alfred Percy Hill with the same staff as hitherto.

WE are informed that the following changes have been made in the directorate of William Denny and Brothers, Limited, of Leven Shipyard, Dumbarton:—Mr. Maurice E. Denny has been appointed chairman of the company, and is succeeded in the deputy chairmanship by Mr. John M. Denny, who formerly signed himself "John M. Denny, Junior." Mr. Walter Brock retires from the board and Mr. Leslie Denny rejoins the board, both as from December 31st current.

PAST AND PRESENT STUDENTS OF UNIVERSITY COLLEGE.—The past and present engineering students of University College, London, will hold their annual dinner, under the chairmanship of Sir Alexander Kennedy, F.R.S., at the Engineers' Club, 39, Coventry-street, London, W. 1, on Thursday, February 1st, 1923. As many students as it is possible to get into touch with are being communicated with directly, but should any past students not receive notices of the dinner, details will be sent to them on application to R. A. Bell, hon. secretary of Past U.C.L. Engineering Students, 116, Worple-road, Wimbledon, S.W. 19.

THORNYCROFT'S EDUCATIONAL SYSTEM.—At the Basingstoke works of John I. Thornycroft and Co., Limited, they have in operation a very thorough system for educating and training their engineering pupils and apprentices. It is the outcome of considerable attention and experience they have given to the subject, and is arranged to allow of theoretical and practical training being given concurrently, which enables the students to understand the "reason why" of their work while their training develops. Some months ago a number of the pupils passed the graduateship examination of the Institution of Mechanical Engineers, and now the following have been successful in passing the recent associateship examination of the Institution:—J. A. G. Bowen, B. F. Gaunt, B. M. Grace-White, B. C. Oldham (honourable mention), A. J. Romer, L. J. F. Rose, G. M. B. Small. At the same time Mr. R. A. S. Physick passed the graduate examination of the Institution.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 7 6	—
No. 1 Foundry	5 0 0	—
No. 3 Foundry	4 15 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 13 0	4 13 0
No. 1	4 13 6	4 13 6
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 11 0	4 11 0
No. 4 Foundry	4 5 0	4 5 0
No. 4 Forge	4 2 6	4 2 6
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
,, Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 3 6	
Forge	3 12 6	—
(3) Lincolnshire—		
Basic	4 0 0	—
Foundry	4 2 6	—
Forge	4 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 10 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. COAST—		
Crown Bars	10 10 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. YORKS.—		
Crown Bars	11 10 0	—
Best ,,	12 10 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	10 7 6 to 10 15 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 15 0	—
Gas Tube Strip	10 10 0 to 10 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 0 0	—
Ship Plates ¼in. and up	8 15 0	—
Sections	8 7 6	—
Steel Sheets ⅛in. to ¼in.	10 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 10 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 0 0 to 9 10 0	—
Angles	8 15 0 to 9 0 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0 to 14 0 0	
Channels	13 10 0	—
Hard Billets	8 15 0	—
Soft Billets	8 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light ,,	9 10 0 to 10 0 0	
Billets	8 10 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 15 0	—
Soft ,,	7 10 0 to 7 15 0	
Hoops	11 15 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	9 0 0 to 9 5 0	
Billets and Sheet-bars	7 5 0 to 7 7 6	
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	17 5 0 to 17 10 0	
Angles	8 15 0	—
Joists	8 15 0 to 9 0 0	
Tees	9 10 0 to 10 0 0	
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/- to 20 3
Block Tin (cash)	180 0 0
,, (three months)	181 10 0
Copper (cash)	64 0 0
,, (three months)	64 17 6
Spanish Lead (cash)	25 15 0
,, (three months)	25 10 0
Spelter (cash)	37 7 6
,, (three months)	34 2 6
MANCHESTER—	
Copper, Best Selected Ingots	67 10 0
,, Electrolytic	71 10 0
,, Strong Sheets	96 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	27 0 0
,, Foreign	26 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined ...		
,, Max. 2 p.c. carbon	£54 0 0	20/-
,, ,, 1 p.c. ,, ...	£64 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free	1/7 per lb.	
Metallic Chromium	4/9 per lb.	
Ferro Manganese ... ... (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 2 6 scale 5/- per unit	
,, ,, 75 p.c.	19 10 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	9/6 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£160	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

		Export.
LANARKSHIRE—		
(f.o.b. Glasgow)—	Steam	23/6
,, ,,	Ell	24/-
,, ,,	Splint	24/6 to 26/6
,, ,,	Trebles	24/-
,, ,,	Doubles	21/9
,, ,,	Singles	16/9
AYRSHIRE—		
(f.o.b. Ports)—	Steam	23/6
,, ,,	Splint	24/6
,, ,,	Trebles	24/-
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—	Steam	22/- to 24/6
Screened Navigation		28/-
Trebles		25/-
Doubles		22/-
Singles		17/-
LOTHIANS—		
(f.o.b. Leith)—	Best Steam	23/9
Secondary Steam		23/-
Trebles		24/-
Doubles		22/-
Singles		17/6

ENGLAND.

(8) N.W. COAST—	
Steams	29/6
Household	46/8 to 57/6
Coke	34/-
NORTHUMBERLAND—	
Best Steams	24/6 to 25/-
Second Steams	21/6 to 22/6
Steam Smalls	12/6 to 14/6
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/- to 25/-
Second ,,	22/- to 23/-
Household	25/- to 28/-
Foundry Coke	37/- to 40/-

SHEFFIELD—	INLAND.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	24/- to 26/- —
,, ,, House	21/6 to 22/6 —
,, ,, Large Nuts	19/6 to 22/6 —
,, ,, Small ,,	15/- to 16/6 —
Yorkshire Hards	20/- to 21/- —
Derbyshire ,,	19/- to 20/6 —
Rough Slacks	9/- to 11/- —
Nutty ,,	7/9 to 9/9 —
Smalls	3 - to 5/- —
Blast Furnace Coke (Inland and Export)	21/- to 30/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	28/- to 29/-
Second ,, ,,	27/6 to 28/-
Best Dry Large	28/- to 29/-
Ordinary Dry Large	27/- to 27/6
Best Black Vein Large	27/6 to 28/-
Western Valley ,,	27/- to 27/6
Best Eastern Valley Large	27/- to 27/6
Ordinary ,, ,,	24/- to 26/-
Best Steam Smalls	18/- to 19/-
Ordinary ,,	15/- to 17/-
Washed Nuts	27/6 to 37/6
No. 3 Rhondda Large	29/- to 31/-
,, ,, Smalls	19/- to 21/-
No. 2 ,, Large	23/6 to 24/6
,, ,, Through	19/6 to 22/6
,, ,, Smalls	14/- to 15/-
Coke (export)	37/6 to 45/-
Patent Fuel	28/- to 30/-
Pitwood (ex ship)	32/6 to 33/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	37/6 to 40/-
Seconds	30/- to 32/6
Red Vein	30/- to 32/6
Machine-made Cobbles	50/- to 52/6
Nuts	65/- to 67/6
Beans	42/6 to 45/-
Peas	22/- to 23/-
Breaker Duff	10/6 to 11/-
Rubbly Culm	14/- to 15/-
Steam Coals:	
Large	25/- to 26/-
Seconds	23/- to 25/-
Smalls	10/- to 12/-
Cargo Through	17/- to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Higher Prices.

As France now possesses raw material resources far in excess of her own requirements, it was believed at one time that prices would be independent of foreign influences, but during the past month values of all kinds of metallurgical products have been steadily advancing, and further increases are recorded this week, beginning with coke, which is quoted up to 110f. The situation is dominated by the supplies of coke, which are quite insufficient for the requirements of blast-furnace owners, who have been obliged to restrict production, and there is accordingly some difficulty in delivering pig iron when foundries are generally backward with the execution of orders. Mill and forge owners are sending increasingly large quantities of rolled iron and steel abroad at low prices, and consumers at home have to pay more for their material. The interests of French buyers are regarded as of less importance at the moment than the national interest in the stabilisation of money values, which it is hoped to attain by exporting as much material as possible. The trade returns for the first eleven months of the year, however, fail to show that this result is being achieved. While the values of imports increased by more than 1486 million francs, the exports declined by 215 millions, notwithstanding that there was an augmentation in the exports of more than five and a half million tons. In weight the imports were more than double the exports, and the values of imports were estimated at 20,977 million francs and the exports 17,803 million francs, thereby indicating that while the country has been purchasing coal, coke and other raw material, it must have been exporting larger quantities of semi-manufactured steel. There was also an increase in the exports of manufactured goods of nearly half a million tons.

Reconstruction.

A number of firms engaged upon reconstruction in the devastated areas have decided that, unless the State pays the arrears due for work already done, they will be obliged to suspend operations. They have taken this course because it is announced that the State has no longer any funds for payment on account of reparation, and if this means a cessation of activity in the devastated regions it will certainly have a detrimental effect upon the manufacturing industries. It was hoped that the arrangement entered into with the German Government would have ensured the carrying out of reconstruction work with the aid of German labour and material, but it is complained that building material is being offered at prices that are often above those ruling in France, and although considerable orders have been passed on to German firms only a comparatively small quantity has yet been supplied. The goods sent to this country on account of reparation are chiefly machinery, which constitutes practically the whole of the consignments during the past month. More than one-third of the total comprised lathes and other machine tools. This importation is objectionable to machine tool firms, which already find themselves nearly destitute of orders. They nevertheless accept the situation because it is the only way at present of getting anything from Germany at all, but agricultural engineers are protesting strongly against the consignments of German machines. This competition of German manufactured goods was only sanctioned as part of the general scheme for carrying out building operations and reconstructing industries in the devastated regions, from which the country generally would benefit, and it is hardly likely to meet with approval if this system of reparation has no other result but to compete with the French engineering trades.

Trans-Saharan Transport.

An interesting experiment in the way of opening up communication between Algeria and the Niger Valley is being carried out with the aid of five small motor cars running on endless rubber tracks of a type that has been successfully employed for a long while past under conditions in which transport by other means is very precarious. The flexible rubber endless tracks have been used on snow-bound mountain passes in the winter, and some scores of touring vehicles have been running for many months. The supple tracks permit of normal speeds being attained, and after long service they show little signs of wear. The five vehicles started last week from Touggourt, to the south of Biskra, an a 2000-mile journey to Timbuctoo, during which they will have to cross 800 miles of desert absolutely devoid of water. This will be the first time the desert has been traversed by vehicles of any kind. The first three stages have been satisfactorily negotiated in the scheduled time, and it is hoped that the cars will reach the Niger during the first days of the New Year.

Restriction on Foreign Enterprise.

The passing of a Bill without discussion through the Chamber of Deputies, depriving foreigners of the right to own landed property in France without the special permission of the State and imposing serious restrictions upon foreign companies, will, if it become law, practically shut out foreign enterprise altogether. Every company carrying on business in this country would have to be under French management and the majority of directors must also be French, while apparently most of the shares must be in French hands. Should the Bill pass through the Senate foreign insurance companies, for example, which are required by law to invest a part of their capital in building property as guarantee, would have to sell, unless, of course, they were transformed into French companies. Business firms could not take leases for more than nine years. The result would be to give a very precarious tenure to foreign firms, while companies would be almost compelled to turn over their business here to French concerns.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

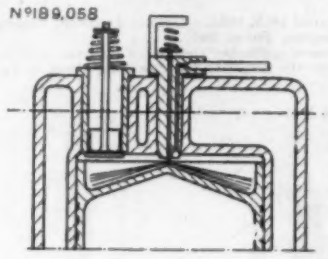
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES

189,058. April 25th, 1922.—FUEL INJECTION JETS, K. J. E. Hesselman, Saltsjo-Storangen, near Stockholm, Sweden.

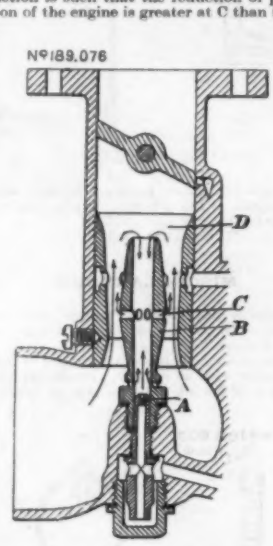
IN order to improve the combustion of the fuel in oil engines the inventor makes the combustion space of the shape shown



and injects the oil as indicated. The object aimed at is to increase the volume of any part of the combustion space as it increases in distance from the jet, and thus provide more air for the combustion of the fuel.—*November 23rd*, 1922.

189,076. October 4th, 1921.—CARBURETTERS, G. Griffin, No. 50 bis, Rue de Douai, Paris.

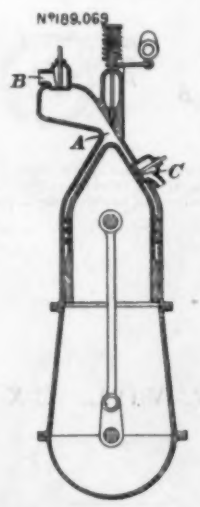
In this carburetter the jet A is surmounted by a funnel B which is arranged inside a contracted orifice in the inlet pipe. The construction is such that the reduction of pressure caused by the suction of the engine is greater at C than it is at D. The



result is a counter current flowing down the funnel, from the top to the centre, as shown by the arrows, which encounters the rising mixture from the jet and completes the atomisation of the fuel.—*November 23rd*, 1922.

189,069. June 12th, 1922.—FOUR-STROKE OIL ENGINES, Kamakichi Takata, No. 2, Higashi Kobaicho, Kanda-Ku, Tokyo, Japan, and A. Ritter, No. 2, Eiraku-cho Nochome, Kojimachi-ku, Tokyo.

According to this specification, the fuel is sprayed into a restricted passage A connecting the combustion chamber with the working cylinder. The fuel is injected during the compression stroke at or about the same time that the piston

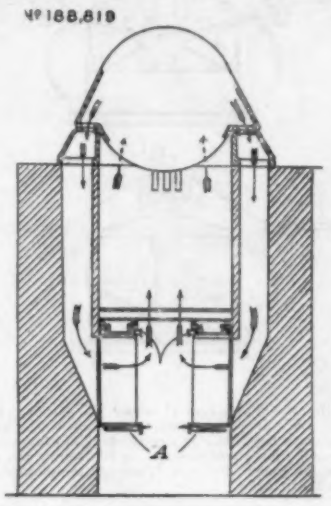


reaches its highest velocity. The injection is directed against the flow of the compressed hot air driven through the passage A by the working piston. The atomised fuel is mixed with the hot air passing at high velocity through the passage and is forced back into the combustion chamber, where further vaporisation and partial gasification take place by the increasing temperature of the compression. The time and duration of injection are not of such consequence as regards the indicator diagram in this internal combustion engine, in which combustion takes place at practically constant volume, and therefore the adjustments of the mechanical means for injection need not be as sensitive as in engines of the constant-pressure cycle (Diesel engines.) The air intake valve is marked B and the exhaust C.—*November 23rd*, 1922.

DYNAMOS AND MOTORS.

188,819. August 26th, 1921.—IMPROVEMENTS IN AND RELATING TO COOLING AND VENTILATING SYSTEMS FOR DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Limited, of 83, Cannon-street, E.C. 4, and Henry William Taylor, of St. Mark's-avenue, Old Bilton, Rugby.

As shown in the drawing, the cooling chamber for the air used for ventilating the machine in accordance with the closed circuit system is situated in the machine foundation, and at the sides of the chamber there are air ducts. Corresponding airways are

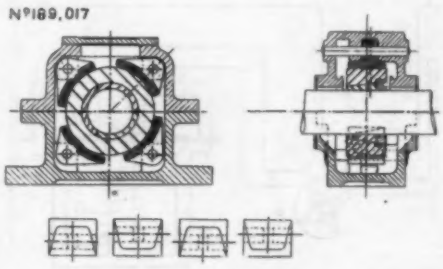


also provided in the base plate of the machine. The direction of the air currents is indicated by the arrows, and it will be seen that in circulating through the chamber the air has to pass through the coolers A.—*November 23rd*, 1922.

TRANSMISSION OF POWER.

189,017. January 26th, 1922.—MICHELL BEARINGS, Michell Bearings, Limited, 3, Central-buildings, Westminster, and H. T. Newbigin.

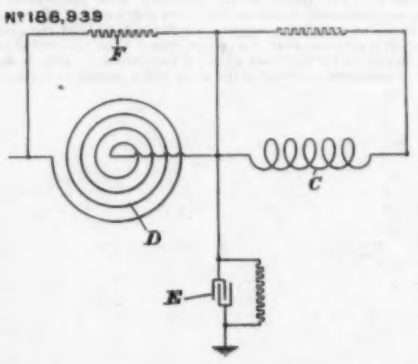
This invention is an improvement on the Michell type of journal bearing and has for its object the more efficient lubrication of the bearing pads, each of which otherwise tends to rob the following pads of oil. The pads are thus made of



trapezoidal form, as shown in the diagram, which is a development of the four pads. The surplus oil from any one pad is dragged on by the shaft along the sinuous path between the pads, and each thus receives a share of lubrication.—*November 23rd*, 1922.

188,939. November 7th, 1921.—IMPROVEMENTS IN OR RELATING TO LIGHTNING OR SURGE ARRESTERS FOR ELECTRIC CONDUCTORS, A. Reyrolle and Co., Limited, of Hebburn-on-Tyne, and William Davis Owen, of 40, Holly-avenue, Jesmond, Newcastle-upon-Tyne.

The arrester in this specification is made up of two main portions, an ordinary inductance C having negligible or normal self capacity, and an inductance D constructed to have a high self capacity. These two inductances are connected in series



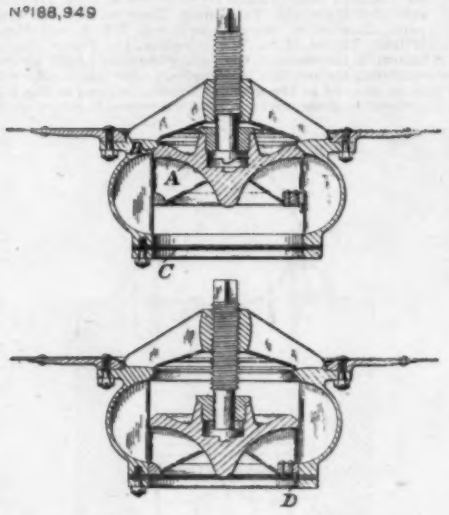
with the line and are connected to earth through a condenser F. The inductance D is shunted by a non-inductive resistance F, and other non-inductive resistances are also shunted across the inductance C and the condenser E respectively. The arrester

is said to be efficient when dealing with both high and low-frequency disturbances and also disturbances due to static charges.—*November 23rd*, 1922.

AERONAUTICS.

188,949. November 15th, 1921.—EMERGENCY DISCHARGE VALVES FOR FUEL TANKS, W. T. Reid and The Bristol Aeroplane Company, Limited, Filton House, Bristol.

This valve is intended for the rapid discharge, in cases of emergency, of the contents of the fuel tanks on aeroplanes. In normal running conditions the valve A is pulled up against the seating B and an additional check against the loss of fuel is

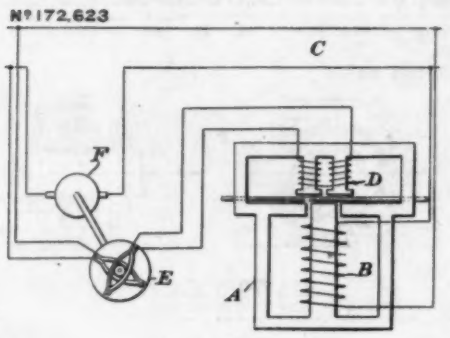


provided by the diaphragm C across the outlet. In case of emergency the valve is opened, and towards the end of the opening process the cutter D pierces the diaphragm and cuts it out. There is then a free passage for jettisoning the fuel. The valve can, of course, be shut again for temporary service.—*November 23rd*, 1922.

MEASURING AND TESTING INSTRUMENTS.

172,623. November 28th, 1921.—IMPROVEMENTS RELATING TO ELECTRICAL MEASURING INSTRUMENTS, *The Metropolitan-Vickers Electrical Company, Limited, of 4, Central-buildings, Westminster.*

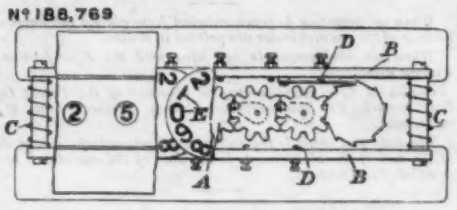
This invention has special reference to volt-ampère-hour meters. The instrument A is an ordinary watt-hour meter. The potential winding B is directly connected across the circuit C, whilst the current winding D is joined to one winding of an induction regulator E, and the other winding of the regulator across the main circuit C. The induction regulator is mech-



anically connected to an alternating-current torque motor F which is connected in series with the circuit C and is deflected in accordance with the currents which this circuit carries. With this arrangement the motor armature is operated in proportion to the direct product of the voltage and current in the circuit C or in accordance with the volt-amp res and irrespective of the power factor.—*November 23rd*, 1922.

188,760 August 16th, 1921. — IMPROVEMENTS IN AND RELATING TO MAGNETIC DETENTS FOR REVOLUTION COUNTERS, Evershed and Vignoles, Limited, of Acton Lane Works, Chiswick, W. 4, and John Cuthbert Needham, of the same address.

The toothed wheels A are made of soft iron and are arranged between two iron plates B connecting the poles of electro-magnets C. The plates B are provided with projections D, which are arranged to co-operate with the teeth of the wheels so as to act as a magnetic detent, which tends to hold the wheels A in such a position that one of the figures E on the dial is centrally actuated in the front plate of the counter. This locking effect is sufficient to prevent the dials being turned accidentally by vibration or lack of balance of the moving parts, but it does not prevent the dials being turned by the rotation of a com-

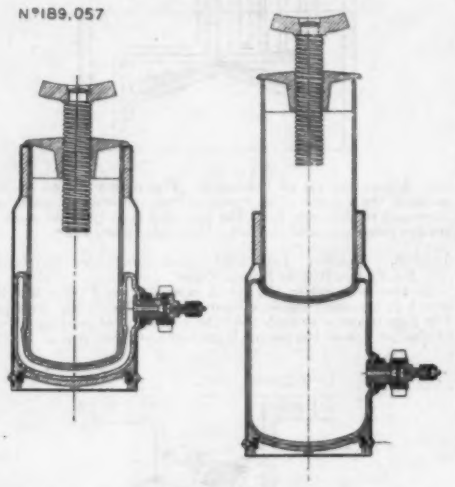


paratively small force, and they can easily be moved by hand.—*November 16th*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

189,057. April 24th, 1922.—LIFTING JACKS, E. Caretta, No. 30, Via Legano, Turin, Italy.

The inventor minimises the loss of air from pneumatic jacks and obviates the necessity for a packing gland by arranging a

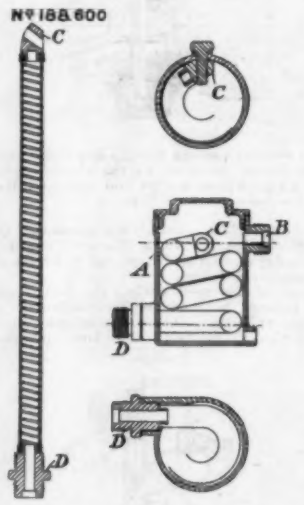


flexible receptacle of rubber between the body and ram of the jack. The operation of the device is obvious from the drawings. —*November 23rd*, 1922.

MISCELLANEOUS.

188,600. February 7th, 1922.—FILTERS FOR LIQUID FUEL, J. Château, 35, Boulevard de la République, Millau, Aveyron, France.

This filter comprises a chamber A arranged in the fuel supply pipe, and provided with an inlet B. Inside the chamber there is coiled a length of flexible tube formed by reinforcing a tube



of filtering material with a wire spiral. One end of the tube is provided with a lug C for attachment to the inside of the chamber, while the other end has an outlet nipple D.—*November 16th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "Brewery Engineering" (slides), by Mr. C. F. Morgan. 7.30 p.m.

SATURDAY, DECEMBER 30TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Juvenile Lecture, "Six Steps Up the Ladder to the Stars"—II.: "Discovery of Neptune," by Dr. H. H. Turner. 3 p.m.

1923.

MONDAY, JANUARY 1ST.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Paper, "Air Transport," by Mr. F. Handley Page. 5.30 p.m.

TUESDAY, JANUARY 2ND.

MANCHESTER ASSOCIATION OF ENGINEERS.—Paper: "The Separation of Materials by Mechanical Means," by Mr. C. Bentham. 7 o'clock.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Juvenile Lectures, "Six Steps Up the Ladder to the Stars"—III.: "Photographing Stars," by Dr. H. H. Turner. 3 p.m.

WEDNESDAY, JANUARY 3RD.

INSTITUTION OF SANITARY ENGINEERS.—Caxton Hall, Westminster, S.W. 1. Presidential address. 7.30 p.m.

WEDNESDAY AND THURSDAY, JANUARY 3RD AND 4TH.

THE PHYSICAL SOCIETY OF LONDON AND THE OPTICAL SOCIETY.—Imperial College of Science, South Kensington, S.W. 7. Annual Exhibition. Afternoon, 3 to 6 p.m.; evening, 7 to 10 p.m.

THURSDAY, JANUARY 4TH.

INSTITUTION OF ELECTRICAL ENGINEERS, Savoy-place, Victoria Embankment, W.C. 2. Lecture. "Variable-speed A.C. Motors without Commutators," by Mr. F. Creedy. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Juvenile Lectures, "Six Steps Up the Ladder to the Stars"—IV.: "Spectroscope and Starland," by Dr. H. H. Turner. 3 p.m.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Lecture: "Metal Aeroplanes," by Professor Junkers. 5.30 p.m.

FRIDAY, JANUARY 5TH.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "Wave-Power Transmission," by Mr. W. Dinwoodie. 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Paper, "South African Railways and Rolling Stock," by Mr. H. K. Bamber. 7 p.m.

SATURDAY, JANUARY 6TH.

WEST YORKSHIRE METALLURGICAL SOCIETY.—Great Northern Hotel, Bradford. Smoking concert. 7 p.m.

TUESDAY, JANUARY 9TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower-hill, E. 1. "Gas Engines and Gas Producer Plant," by Mr. Hugh Campbell. 6.30 p.m.

WEDNESDAY, JANUARY 10TH.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Paper, "The Selection of Fans and their Application," by Mr. A. Fleming Brown, 7.30 p.m.

THE INSTITUTION OF STRUCTURAL ENGINEERS: LANCASHIRE AND CHESHIRE BRANCH.—Engineering Laboratory, Victoria University, Manchester. Paper, "An Investigation of the Theory of Flexual Resistance," by Mr. A. S. Spencer. 7.15 p.m

THURSDAY, JANUARY 11TH.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Juvenile lecture: "Testing Model Seaplanes," by Mr. R. A. Fraser. 3 p.m.

FRIDAY, JANUARY 12TH.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Paper, "Transient Phenomena Arising in Transformers from Switching Operations," by Mr. S. A. Stigant. 7.30 p.m.

SATURDAY, JANUARY 13TH.

INSTITUTION OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Grand Hotel, Manchester. Smoking concert. 6 p.m.

THURSDAY, FEBRUARY 1ST.

PAST AND PRESENT ENGINEERING STUDENTS OF UNIVERSITY COLLEGE, LONDON.—The Engineers' Club, 39, Coventry-street, London, W. 1. Annual dinner.

ERRATUM.—In the description of the new lifeboat engine given on page 639 of our issue of last week, the total weight of the engine and its accessories was, by the dropping of a figure, given as being 7 cwt. The actual weight is 37 cwt.

END OF VOL. CXXXIV.

Easton & Anderson

Proprietors,
The Pulsometer Engineering Company,

Pumping Machinery

for Sewage and Water Works.

11, Tothill Street, LONDON, S.W.
Works, READING.

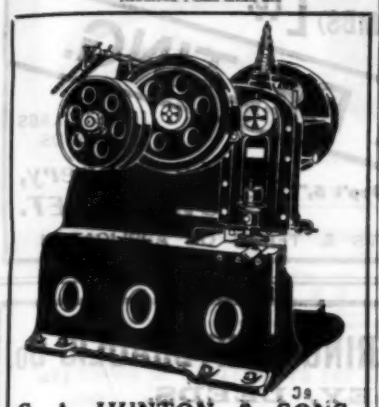
Telephone 185. "PREMIER" Telephone 153.

NON-CONDUCTING COMPOSITION.

For Boilers, Steam Pipes, Fans, Heaters, Feed-water Pipes, etc. Greatest economy by using our Premier Composition.

Established 1858. **JOHN FLEWITT,** Bridge Yard, WIDNES. Established 1858.

Estimates Free. All work guaranteed.
Coverings of Magnesia (Plastic or Sectional), Slag Wool, Asbestos, Fossil Meal, &c.



C. A. HUNTON & SONS,
71, Southwark St., London, S.E. 1

THE "PRACTICAL ENGINEER" Mechanical Pocket Book and Diary

1923

(THIRTY-FIFTH YEAR OF ISSUE).

Some Special Features:

Buyer's Guide in English, French, Spanish and Russian.
Steam: Generation, Turbine and other Engines, Condensers. Gas and Oil Engines.
Air: Compression, Ventilation, Heating. Hydraulics and Hydraulic Machinery.
Machine Tools and Engineering Materials.
Pipes, Beams, Girders, Columns, etc. Friction and Power Transmission.
Gas for Heating and Lighting. Pyrometry.
Diary (one week to the page), etc. etc. etc.

An Ideal Size for the Pocket (5¼" × 3¼"),

2/6 (cloth)
(or 3/- in leather-cloth).

Obtained by return of post from:—

H. R. ELLIS, Bookseller,
9, Lovell's Court, Paternoster Row, London, E.C. 4.

THE ORIGINAL AND GENUINE

HAMMERED CAST IRON PISTON RINGS.

(By the Davy-Robertson Process.)

In our special quality 2 K 6 piston ring iron. All sizes up to 72in. diameter.

QUICK DELIVERY.
ABSOLUTELY RELIABLE.
LOW PRICES.

Our Hammered Piston Rings are well and favourably known all over the world for their efficiency and long wearing qualities. They keep the cylinders round and maintain a perfect joint until worn out. The pressure on the cylinder wall always remains constant.

The Standard Piston Ring & Engineering Co. Ltd.,
PREMIER WORKS,
Don Road, SHEFFIELD.

Telephone No. 2169
Telegrams—Ocean, Sheffield

W. G. BAGNALL, LD.

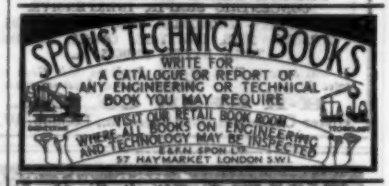
STAFFORD.

BUILDERS OF LOCOMOTIVES

Weighing from 3 to 60 tons, for any gauge, of Highest-class Workmanship and Material.

MAKERS OF
Tipping Trucks, Sugar Cane Wagons, Turntables, Switches, &c. Spl 3024

See Illustrated Advt. alternate issues.


SPONS' TECHNICAL BOOKS
WRITE FOR
A CATALOGUE OR REPORT OF
ANY ENGINEERING OR TECHNICAL
BOOK YOU MAY REQUIRE
VISIT OUR RETAIL BOOK ROOM
WHERE ALL BOOKS ON ENGINEERING
AND TECHNOLOGY MAY BE INSPECTED
E. & F.N. SPON LTD.
57 HAYMARKET LONDON S.W.1.

LOCOMOTIVES FROM STOCK.

ALL GAUGES & SIZES.

KERR STUART'S

8, Broad St. Place, London, E.C.

REDPATH, BROWN & Co., Ltd.

Structural Engineers and Steel Merchants

Edinburgh, London, Manchester, Glasgow, Newcastle & Birmingham.

See our Advt. on Pages 48, Dec 8th.

FITTINGS

WATER, STEAM, AIR AND HOSE.

DEKTEREFF, FRANCKE & REPPMAN, 118, Queen Victoria St., London, E.C. 4.

WATER

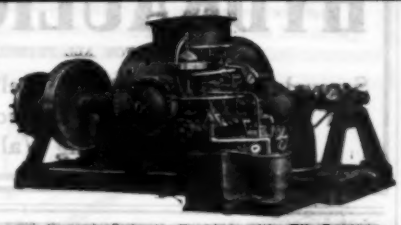
TURBINES

OF THE MOST EFFICIENT TYPES

MODERN

PELTON WHEELS

FOR HIGH FALLS.



Twin Gunther-Francis Turbine with Oil Governor.

W. GUNTHER & SONS, CENTRAL WORKS, EDMONTON

J. E. WESTLE & COMPANY

(J. E. WESTLE, for 23 years associated with the late Mr. Charles H. Scott, M.I.M.E.)

SPECIALISTS IN

LINOLEUM, FLOORCLOTH, LINCRUSTA, CORK BREAKING, GRANULATING & SIFTING MACHINERY, CORK SLAB PLANTS, &c.

Telegraphic & Cable Address: "WESTLIN, GLOUCESTER." EASTGATE HOUSE, GLOUCESTER. Telephone: 93 GLOUCESTER. Code: A B C (5th Edition).

The Mitchell Conveyor & Transporter Co., Ltd.,

CONTRACTING ENGINEERS.

Designers and Builders of all Classes of Handling Machinery.

Atlantic House, 45-50, Holborn Viaduct, - - London, E.C. 1.

Telegrams: MICONTRACO, CENT, LONDON. Telephone: HOLBORN 280.

Screwed 1in.,1¼in.,1½in.,&2in.Gas Thread on Seating.

"National" Patent Fusible Plugs

National Boiler & General Insurance Co. Ltd.
Sales Dept.
St Mary's Parsonage,
Manchester.
London Office:
60, Queen Victoria St. E.C.

Illustrated Price List on application.

STEAM CRANES

ELECTRIC CRANES

Telegrams: "COLES DERBY." Telephone: 1366 DERBY.

HENRY J. COLES, Ld., LONDON CRANE WORKS, Derby.

A SOUND JOB IN MINIATURE

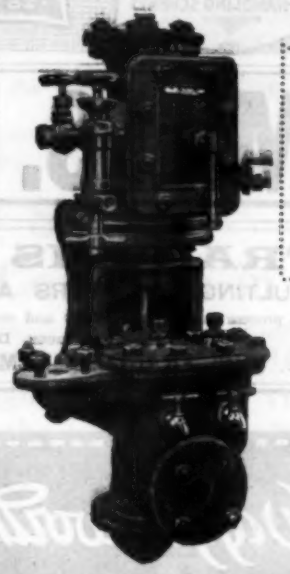
ASTER

(ANTHONY)

Gearless Simplex Donkey Pump

FROM 100 TO 1050 GALLONS PER HOUR.

REDUCTION IN PRICES OF ALL SIZES.



DELIVERY FROM STOCK (IN FIVE STANDARD SIZES.)

THE ASTER ENGINEERING CO. (1913), LTD.,

Telegrams: ASTER, WEMBLEY. WEMBLEY, MIDDLESEX. Telephone: WEMBLEY 22 & 23.

THE H-R GEAR

Reduction, Reversing & Multi-Speed.

AN ENTIRELY NEW PRINCIPLE.

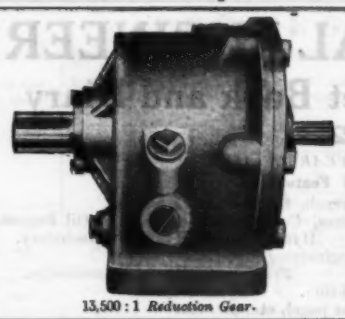
POSITIVE REDUCTIONS UP TO 1,000,000 TO 1.

COMPACT, SILENT, EFFICIENT, DURABLE, CONCENTRIC SHAFTS, INEXPENSIVE.

Applicable to:—AUTOMOBILES, MECHANICAL STOKERS, TURBINES, LIFTS, CONVEYORS, CRANES, MACHINE TOOLS, BASCULE BRIDGES, etc.

If you have a Transmission Problem this Gear will solve it. Manufacturing Licences granted.

H-R GEAR CO., Ltd.,
Ulster Chambers, 168, Regent St., London, W. 1



13,500 : 1 *Reduction Gear.*

RICHD. D. BATCHELOR,

ARTESIAN & CONSULTING WELL ENGINEER

Established over a Century.

CONTRACTOR TO ADMIRALTY AND WAR OFFICE.

WATER SUPPLIES.

Air Lifts, Steam, Gas, Oil, and Electric Pumps.

UNCOMPLETED WORKS UNDERTAKEN

73, QUEEN VICTORIA ST., LONDON.

Wires { Borholes, London / Water-bed, Chatham } Artois Works, CHATHAM.
Phone: 4725 City and Chatham 71.

"Cronite" *FOR ALL TEMPERATURES WHERE OTHER METALS COLLAPSE.*

Melting Point 1420° C. For Locomotive Parts, Heat Treatment Vessels, Glass Plant, Distillation Work.

The CRONITE FOUNDRY Co., Ld., 30, Lawrence Road, Tottenham, N.15.

WEBB & SON, (COMBS) LTD.

Tanners and Curriers,

MANUFACTURERS OF OAK TANNED

LEATHER BELTING.

12 FIRST-CLASS AWARDS.

"Dep't S," *Combs Tannery, STOWMARKET.*

PRICE LISTS & TERMS ON APPLICATION.

SMITHS FOR VALVES.

ANY TYPE ANY PRESSURE ANY PURPOSE.

SMITH BROS. & CO. (HYSON) LTD., NOTTINGHAM

Telegrams: "HYSON." Telephone: 1518.

THE LEEDS ENGINEERING & HYDRAULIC Co. LTD

RODLEY, LEEDS,

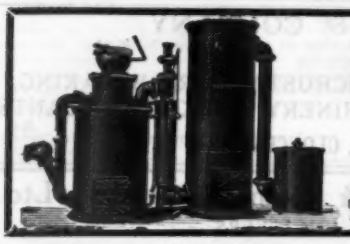
SPECIALISE ON

HYDRAULIC VALVES

FOR ALL PRESSURES SUCH AS

Screwdown, Momentum, Relief, Combined Momentum and Relief, Reducing, Deflecting, Automatic Unloading, Operating Valves, etc., etc.

Telephone—No. 150, Stanningley, Leeds. Telegrams—"Pumps, Rodley." Code: A B C, 5th Edition.



DANIELS'

SUCTION GAS PLANTS

Will work perfectly from full load to no load.
5-10 H.P. for one penny per hour.
Simple. Reliable. Economical.

T. H. & J. DANIELS, Ltd., STROUD. England.

Siemens-Martin Steel Angles, Tees, Flats, Rounds, Squares, Ovals, Convex, Copes, Firebars, Channels and Special Sections. Also Ingots, Billets, Blooms, Sheet Bars.

HOOPS

Plain, Splayed.

Also for Cotton Ties, etc.

Tel. Address—"Hoops," Motherwell.

The Motherwell Iron & Steel Co. Ltd., Motherwell

CENTRIFUGAL PUMPS

LOW & MEDIUM LIFT PUMPS

MULTI-STAGE TURBINE PUMPS for HIGH LIFTS.

See our large advertisement in issue of Dec. 22nd.

F. A. PULLEN & CO
ENGINEERS

Empire Works, 58a, Harleyford Road, London, S.E. 11.

Makers: ROYAL DUTCH ENGINE WORKS, HELMOND, HOLLAND.

AUTOMATIC SELF-CLEANING EVAPORATOR

(PRACHE & BOUILLON PATENTS.)

P. & B. EVAPORATORS, LTD.

(Sole Licensees of La Société Générale D'Evaporation Procédés Prache and Bouillon, Paris).

2, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W. 1.

See Illustrated Advertisement in last issue and also next week.

BOILER HOUSE EXPERTS
MECHANICAL STOKERS
COMPLETE COAL AND ASH-HANDLING SCHEMES

ED. BENNIS & CO. LTD.

LITTLE HULTON —— BOLTON and
28 VICTORIA STREET · WESTMINSTER · LONDON S.W.1

LOOK OUT FOR OUR FULL-PAGE ANNOUNCEMENT ON JANUARY 12.

OIL MILLS.

ESTABLISHED 1777.

ROSE, DOWNS & THOMPSON, Limited.

HULL, LONDON, AND SHANGHAI.

DREDGERS and EXCAVATORS.

THE FRANCOIS CEMENTATION COMPANY, LTD.,

CONSULTING ENGINEERS AND CONTRACTORS. EXPERIENCED CEMENTATION SPECIALISTS.

Our Cementation process can be successfully and economically applied to overcome difficulties due to water or bad ground in the original construction or repairs of—

Tunnels, Aqueducts, Dams, Retaining Walls, Wells, Storage Reservoirs, Foundations, Culverts, &c.

Tels. "François, Doncaster." **THE FRANCOIS CEMENTATION COMPANY LIMITED, - - Bentley Works, DONCASTER.** 'Phone: 413, Doncaster.

J. Wigglesworth & Co Ltd

SHIPLEY ~ YORKS

SHAFTING

Easier Work
MEANS
Greater Output.

GOOD TOOLS
SAVE MONEY.

Portable Grinding Machine.

The greater ease of operation afforded by the flexible driving shaft fitted to this Wolf Portable Grinding Machine enables the output of your factory to be considerably increased. These awkward corners which have previously been inaccessible can now be ground as easily as if the work was on the flat.

WOLF Electric TOOLS

S. WOLF & CO., LD.
115, SOUTHWARK STREET,
LONDON, S.E. 1.

Telephones:
CENTRAL 5172 and HOP 2734.
COVENTRY: 6, Warwick Row.

Electric Bench Drill.

With a Wolf's Electric Bench Drill illustrated here your operator can get at any job in a moment—no matter what it may be—easily, quickly and without fatigue, thus reducing production costs by many hours' work.

May we send you particulars of these and our many other electric tools for all purposes?

K. HOLST & Co.
1, VICTORIA STREET, WESTMINSTER, S.W. 1.
Engineers & Contractors for all types of Structural Work in
FERRO-CONCRETE
Preliminary Designs and Estimates submitted free of charge. Write for Brochure.

Foliac

The paint pigment against which rust is powerless is Foliac Graphite.

Its incorporation in Foliac Silica-Graphite Paint gives a marvellous smoothness, huge covering power, and a thorough protection against corrosive influences.

Before deciding on your next paint supplies write us for prices and particulars of Foliac Silica-Graphite Paint—it is British made.

Manufactured solely by
GRAPHITE PRODUCTS, LTD.,
218/220, Queen's Rd, Battersea, LONDON, S.W. 8

SILICA-GRAPHITE
PAINT.

HOLMAN
All New Standard Verticals fitted with patent 'FETHER-PLATE' VALVES
AIR COMPRESSORS
Write or call at HOLMAN BROS., LTD., CAMBORNE, ENGLAND.
LONDON OFFICE - - Broad Street House, E.C.2.

WE CAN LEND YOU A HAND.

THOMAS PIGGOTT & CO., LTD.
SPRING HILL, BIRMINGHAM.

TANKS FOR WATER STORAGE FROM STOCK.

The Strongest on the Market. 15,000 Tons supplied.

LOST!

29,000,000 Tons of Steel through Corrosion in 1920.

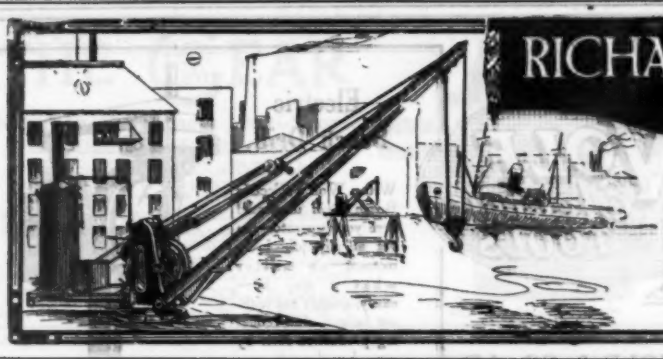
The above startling statement was made by Sir Robert Hadfield in a Paper read before the Institute of Civil Engineers last April.

This irreparable loss might have been very largely PREVENTED by the use of

"BITUMASTIC" (REGD) *The "World's Record" Anti-Corrosive.*

"Bitumastic" Coloured Solutions
Are supplied ready for application in the same way as ordinary paints, in Black, Red, Brown, Green or Grey.
The solutions render corrosion impossible by keeping the causes of rust from reaching the surface of the metal.
A Postcard will bring full details.

Wailes Dove Bitumastic Ltd., Newcastle-on-Tyne,
London, Glasgow, Liverpool, Birmingham, Manchester, Leeds, Cardiff, Hull, etc.



RICHARD C. GIBBINS & Co.
Berkley Street,
BIRMINGHAM
Makers of Steam Electric & Hand Cranes.
All kinds of Lifting Tackle

"BRITNIC"
—4,000,000 H.P. in service—
WATER TUBE BOILERS & MECHANICAL STOKERS.
200,000 H.P. in service.
THE BRITISH NICLAUSSE BOILER CO., LTD.
The Clock House, Arundel St., Strand, W.C.

The VAUGHAN CRANE Co., Ltd.,
MANCHESTER.
Travelling Cranes—Runways—Pulley Blocks.

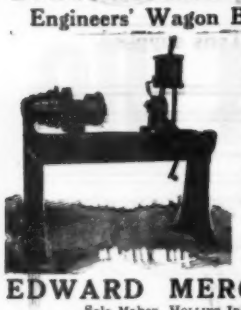
ELWELL PARKER
Electric Trucks and Tractors reduce Manufacturing Costs. Write for descriptive catalogue.
Sole British Agents:
GILLESPIE PARTNERS, Ltd.
80, Gracechurch St., London, E.C. 3.

COCKBURN
LIMITED
CARDONALD
GLASGOW
The World Renowned Steam Valve Specialists
See Illustrated Advt. in alternate issues.

Budenberg Gauge Co., Ltd.
(Late Schaffer & Budenberg, Ltd.)
BROADHEATH,
nr. Manchester.
Branches:—LONDON and GLASGOW.
MAKERS OF
PRESSURE GAUGES,
TACHOMETERS, COUNTERS
DIAL-THERMOMETERS,
TEST-PUMPS, &c.

Self-Recording Instruments for Pressure, Temperature and Speed.

To SCREW BOLT MAKERS
Engineers' Wagon Builders, &c.



This Patent Screwing Machine can be worked either by a Boy or Girl, and will screw at the rate of from 25 to 30 gross of ¾in. bolts per day of ten hours, or other sizes at proportionate speed. This Machine is also well adapted for Tapping Nuts.
As supplied to Governments.
Prices and particulars on application.
EDWARD MERCER, Ltd.,
Sole Maker, Hollins Ironworks,
HOLLINWOOD, near MANCHESTER.

COAN CASTS CLEAN CRANK CASES
ALUMINIUM CASTINGS FOR ALL TRADES
SAND OR DIE. ANY SIZE.
ROBERT W. COAN,
219, Goswell-road, London, E.C. 1.
Enquiries invited. Maker of number plates.

DOUGLAS FRASER & SONS, Ltd.
ARBROATH.
MILL GEARING, BELT PULLEYS, & ROPE PULLEYS.
See Illustrated advt. last week, page 7½.

CENTRIFUGAL and TURBINE PUMPS

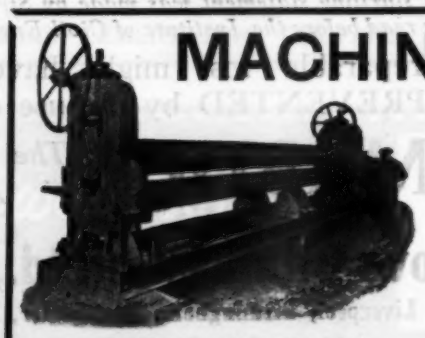
For Lifts up to 3,000ft.

The above illustration is of our A B. 12 High Lift Centrifugal Pump for lifts up to 100 feet. The pump is of very substantial construction and of high efficiency.
Write for List No. 841.

Pulsometer Engineering Co Ltd
Offices:- 11, Tothill Street, WESTMINSTER, S.W.
Works:- Nine Elms Iron Works, READING.

IMPROVED
GIANT GRIFFIN MILL.
The most efficient unit for pulverizing:—
PORTLAND CEMENT, LIMESTONE, COAL, SLATE WASTE, BASIC SLAG, PHOSPHATE ROCK, ORES OF ALL KINDS.
Finishes in One Operation.
BRADLEY PULVERIZER CO.,
37, WALBROOK, LONDON, E.C. 4.
BULK SAMPLES pulverized in our London Demonstration Plant.

MACHINE TOOLS
FOR
Straightening, Bending, Sawing, Planing
PLATES, BEAMS, BARS
as supplied to Government Workshops.



Chambers, Scott & Co. Ltd.
MOTHERWELL.
26ft. BENDING ROLLS, Direct Motor Driven

THE GRANTHAM BOILER & CRANK Co. LTD. GRANTHAM
ALL SIZES
ALL TYPES

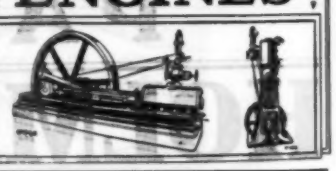
MANUFACTURERS OF STEAM BOILERS.
TRADE TERMS ON APPLICATION
Also Air Receivers & Feed Water Heaters.
Bent Cranks. Forgings or Finished.

THE DRUM PUMP
THE DRUM ENGINEERING Co. LIMITED,
28, HUMBOLDT ST., BRADFORD.

METAL SAWING MACHINERY
ENGINEERS
CLIFTON & WADDELL, and JOHNSTONE,
OVER 1000 MACHINES IN USE.
See Illustrated Advts. last week and next.

GLYNE ENGINEERING Co. Ld.
WATER COOLERS. CONDENSING PLANTS.
VACUUM PUMPS & COMPRESSORS.
STEAM TRAPS, &c.
Telephone: 4070 City. Telegrams: Modernize, Manchester
94, MARKET STREET, MANCHESTER.

T. & R. LEES, Ltd.
HOLLINWOOD.
STEAM ENGINES



ERNEST NEWELL & Co., Ltd.,
Misterton, Doncaster.
Makers of all Machinery for the manufacture of Portland Cement—Wet or Dry Process.

PARAFFIN ENGINES
PARSONS MOTOR Co. Ltd.
TOWN QUAY SOUTHAMPTON

"RAPID"
ELECTRO-MAGNETIC SEPARATORS and GRINDING CHUCKS.
RAPID MAGNETTING MACHINE Co., Ld.
40, Magnet Works, Lombard Street,
BIRMINGHAM.

CRANES
Derrick & Overhead Travelling Cranes
Worked by Hand, Power and Electric.
JOHN SMITH (Keighley), LTD.
See last week's advertisement page 7½.

"SIMONS" PATENT CUTTER HOPPER DREDGERS

MARINE DREDGE PLANTS— of all descriptions and up to the highest capacity.

CONSTRUCTORS OF HOPPER & BARGE-LOADING BUCKET DREDGERS; BARGE-LOADING, RECLAMATION & "SIMONS" CUTTER SUCTION DREDGERS.

Proprietors of ALFRED WATKIN'S BRITISH PATENT for ROTARY SPUDS

TRAILING SUCTION HOPPER DREDGERS . . .
GOLD & TIN RECOVERY DREDGERS . . .
HOPPER BARGES. FERRY STEAMERS
REPLACE PARTS for EXISTING DREDGERS.

INVENTORS and FIRST CONSTRUCTORS . . . .
OF "HOPPER" and "STERNWELL" . . .
DREDGERS and ELEVATING . . . .
DECK FERRY STEAMERS . . . .

Telegraphic Addresses:
SIMONS, RENFREW; SIMONDS, LONDON.
CODES: A.B.C. 5th Edition, SCOTT'S, 10th Edition BENTLEY'S.
London Office:
83, VICTORIA STREET.

WM. SIMONS & CO., Ltd., RENFREW, near GLASGOW.

CONVEYOR AND ELEVATOR Co LTD.

LOWER BRIDGE WORKS,
ACCRINGTON, LANCASHIRE.
Contractors to H.M. Government.
Telegrams: CONVEYOR, ACCRINGTON. National Telephone No. 3779.

SPIRAL CONVEYORS
COAL CONVEYORS
GRAIN CONVEYORS
TRAY CONVEYORS
STOKEHOLD CONVEYORS.

GRAIN ELEVATORS
COAL ELEVATORS
CHAIN ELEVATORS
BELT ELEVATORS
BALE ELEVATORS

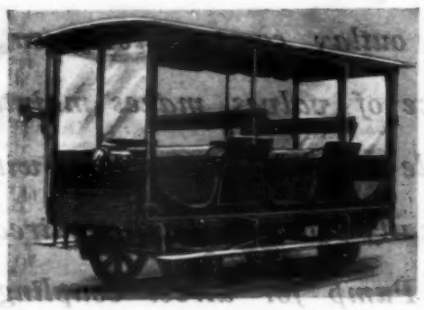
INTERNAL COMBUSTION.

Railway Cars, Coaches, Inspection Cars, Tramway Cars.
Trailers, Trucks, Locomotives, Tractors.
BRITISH BUILT THROUGHOUT.

Giving satisfactory service on over 200 Railways in every part of the World.

Any type of Car or Coach designed and built to meet individual requirements.

Contractors to—
The Admiralty, War Office, India Office, Crown Agents for the Colonies, Colonial and Foreign Governments.



THE DREWRY CAR CO., LTD.
(And McEWAN, PRATT & CO., LTD.).
13, South Place, London, E.C.2.

Telegrams: "Effervesce, London."
Telephone: London Wall 458.

Works:—
Baguley Works,
BURTON-ON-TRENT,
ENGLAND.

DREDGING PLANT

UP TO THE LARGEST DIMENSIONS AND CAPABILITIES.

Bow and Stern Well Centre and Side Ladder, Bucket Barge-loading and Hoppe Dredgers, Suction Dredgers, Hydraulic and Mechanical Agitators, Discharge Pipes and Pontoons, Hopper Barges, Sewage Steamers, Caissons, Tugs, Ferries, Paddle and Screw Steamers.
Delivered Complete or Shipped in Sections. Spare Gear and Renewals Supplied.

FERGUSON BROTHERS (PORT GLASGOW), LD.

Shipbuilders and Engineers,
PORT GLASGOW.

Telegraphic Address: DREDGER, PORT GLASGOW.
On Admiralty List and War Office List.
GRAND PRIZE LONDON EXHIBITION, 1908.
GOLD MEDAL JAPAN-BRITISH " 1912.

Why pay a high price for Water?

Reduce your costs and obtain 1000 Gallons

against 100ft. head

for one penny

by installing a Sulzer Centrifugal Borehole Pump and obtain an independent and constant supply of water at less cost than from the mains.

Simple, efficient and reliable.

Initial outlay comparatively small.

Absence of valves makes maintenance costs negligible.

A single unit only as compared with two for Airlift pumps.

Practically no attention required.

Ideal Pump for direct coupling to electric motor, or bevel gear drive from Diesel, Steam or Gas Engine.

Any depth of Borehole or Well to **over 300ft.**

Minimum quantity of Water 2,000 Gallons per hour.

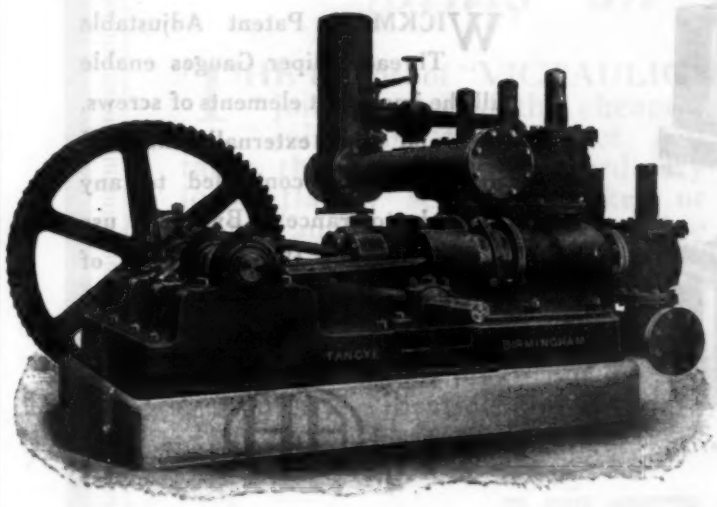
Many of our Borehole Pumps are working in this country.

SULZER BROS.

31, BEDFORD SQUARE, LONDON, W.C. 1.

Swansea: Castle Buildings. Manchester: 21, Spring Gardens.

TANGYE



THREE-THROW

RAM PUMPS

For Mines, Town's Water Supply, &c.

FOR BELT or DIRECT DRIVE by:—

TANGYE { GAS ENGINES, OIL ENGINES, STEAM ENGINES, or with ELECTRIC MOTORS, of any make.

Fitted with

OUTSIDE VALVE SPRINGS for HIGH SPEED.

PRICES REDUCED.

TANGYES LTD. BIRMINGHAM.

408 A R

Something to think about

A new MILLARS' Line of interest to YOU

180 cubic yards of **mixed** material per 8 hour day is the output of Millars' new 14 L Mixer. It's quite portable, and there are some improvements hitherto unknown to mixer construction.

It will appeal to you as a highly-efficient, soundly-constructed money-saver.

Get full particulars while deliveries are good.

MACHINERY DEPT.

MILLARS' TIMBER & TRADING Co., Ltd.,
Pinners' Hall, Gt. Winchester St., LONDON, E.C. 2.

Phone: London Wall 368. 'Grams: "Jarrah, Stock, London."

WORKS: Kirtling Street, Battersea, S.W.

Millars' new 14 L Mixer, 14 to 17 cubic feet mixed material per batch and "a-mix-a-minute." Automatic tipping water tank. Automatic loader. Weight 2¼ tons.

M 138

B

MACHINE CUT GEARS.

CHANGE WHEELS AND STANDS.
All Sizes 1-d.p. to 4-d.p. Accurately Cut by New Process. Very Low Prices. Ask for List

SPUR GEARS.
Standard patterns for all sizes, oval or + section arms, to 2in. pitch, face to suit, to 5ft. diameter.

MITRES AND BEVELS.
To 2in. pitch and 24in. dia. Larger sizes to order.

PAPER & RAW HIDE PINIONS.
SKEW AND WORM GEARS.
CLEAN CASTINGS. Spur Gear Blanks from any of the above patterns. Balance Wheels made up to suit customer, and Castings only supplied if required.
General Machine Castings made to Customers Patterns.
Low Prices for Planing, Boring, Turning, Screwcutting.
Send your Enquiries to—

Greenwood's Standard Gear Cutting Co., Ltd.,
NEW BOND STREET, HALIFAX.
Telephone: 1212 Telegrams: "Gears."

BOBY
WATER SOFTENERS
HEATERS
FILTERS
WILLIAM BOBY & SON,
Salisbury House, LONDON WALL, E.C.

CIRCULATING - WATER SCREENS (Patent)
Pumps and Air Compressors.
F. W. BRACKETT & CO., LTD.
Engineers, COLCHESTER.

BRIQUETTE MACHINERY LTD
CHARMOUTH ST., LEEDS.

BROWNLIE & MURRAY, LTD
STRUCTURAL ENGINEERS
POSSILPARK, GLASGOW.
See Illustrated Advertisement last and next week

BOILERS
Vertical Cross-Tube
THE CONSTRUCTIONAL ENGINEERING CO. LTD.
MAKERS,
CHARLES HENRY STREET, BIRMINGHAM.

STONE BREAKERS,
CONCRETE BREAKERS, MIXERS, DISINTEGRATORS, COKE BREAKERS, MORTAR MILLS and every description of STONE BREAKING and GRINDING MACHINERY
We let them out on hire with Engines; therefore always have a few good second-hand ones to offer.
MASON BROS.,
Stone Breaking Machine Makers,
BRANDON STREET, LEICESTER, ENG.

MECHANS LIMITED,
Engineers & Contractors,
SCOTSTOUN IRONWORKS, GLASGOW.
LONDON OFFICE:
28, Victoria Street, Westminster, S.W.
See Illustrated Advertisement appearing every Fourth Week.

ADJUSTABLE LIMIT GAUGES.
Limit gauges should be adjustable so that wear allowance may be reduced to the minimum.

British Patent Nos. 161242 & 161137.

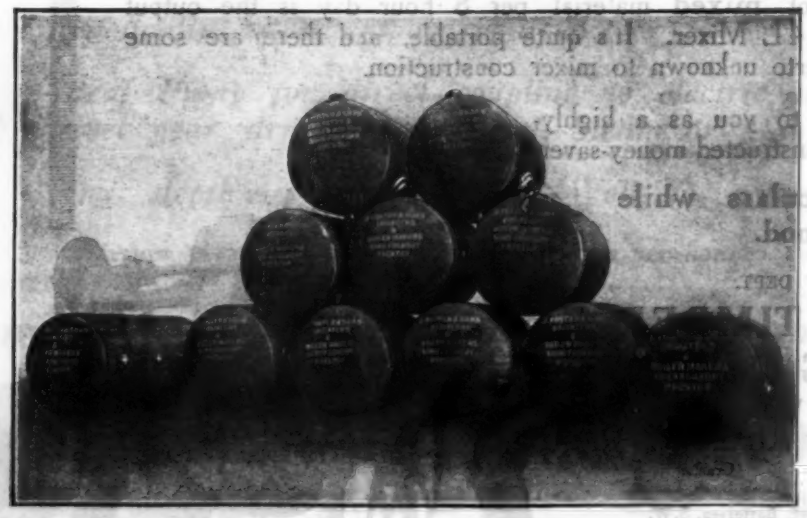
WICKMAN Patent Adjustable Thread Caliper Gauges enable all the important elements of screws, taps and other externally threaded articles to be controlled to any desired tolerance. By their use interchangeable threaded work of any desired quality may be ensured.

AH

British Patent No. 161242.

WICKMAN Patent Adjustable Plain Caliper Gauges enable the fullest possible advantage to be taken of the highly accurate reference gauges now obtainable. Owing to the combined fine adjustment and lock, these gauges can be set to reference slips with great accuracy.

We can give reliable advice on the somewhat complex subject of limit gauging. Write to:—
GAUGE DEPARTMENT
ALFRED HERBERT LTD. COVENTRY.



PRESSURE TANKS READY FOR DELIVERY.

TANKS
FOR ALL PURPOSES
BOTH
RIVETED
AND
WELDED.

OIL
TAR
AIR
WATER
H^2SO_4
CS_2

TANKS

JOSEPH FOSTER & SONS,
ENGINEERS & BOILERMAKERS,
PRESTON LANCS.

One of the cheapest joints on the market

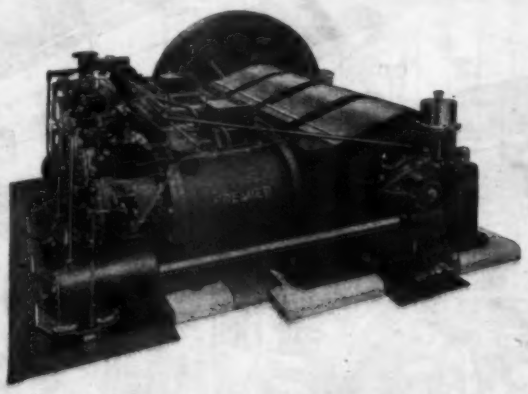
THE leakproof "VICTAULIC" joint is one of the cheapest joints on the market, and takes the place of the ordinary loose flange, screwed socket or spigot and socket joint on pipe lines of any length.

ITS flexibility ensures that the joint remains leakproof despite intense vibration and ordinary ground subsidence. The joint is self-sealing, it is leakproof directly it is placed in position, there is no caulking, adjustment or "making joint"—merely erecting by unskilled labour.

THOSE who are interested in joint-efficiency and joint-economy should send for the "VICTAULIC" booklets, which give really useful information.

The VICTAULIC COMPANY Limited
28, VICTORIA STREET,
LONDON, S.W. 1.

"PREMIER" GAS ENGINES



HORIZONTAL TYPE
MULTI-CYLINDER
120 to 1000 B.HP.

VERTICAL TYPE
MULTI-CYLINDER
FROM 1000 B.HP. UPWARDS.

We were the pioneers in this country of Large Gas Engines, and as we have been responsible for hundreds of important installations during the past 25 years, our experience is unique. Premier Gas Engines are specially adapted for direct coupling to electric generators, both A.C. and D.C., and give low fuel consumption, complete accessibility, and continuous reliability.

THE PREMIER GAS ENGINE CO., LD.
HEAD OFFICE & WORKS: SANDIACRE, Nr. NOTTINGHAM.
LONDON OFFICE: 139-141, QUEEN VICTORIA STREET, E.C. 4.

ON ADMIRALTY, WAR OFFICE, COLONIAL AND ALL LISTS.

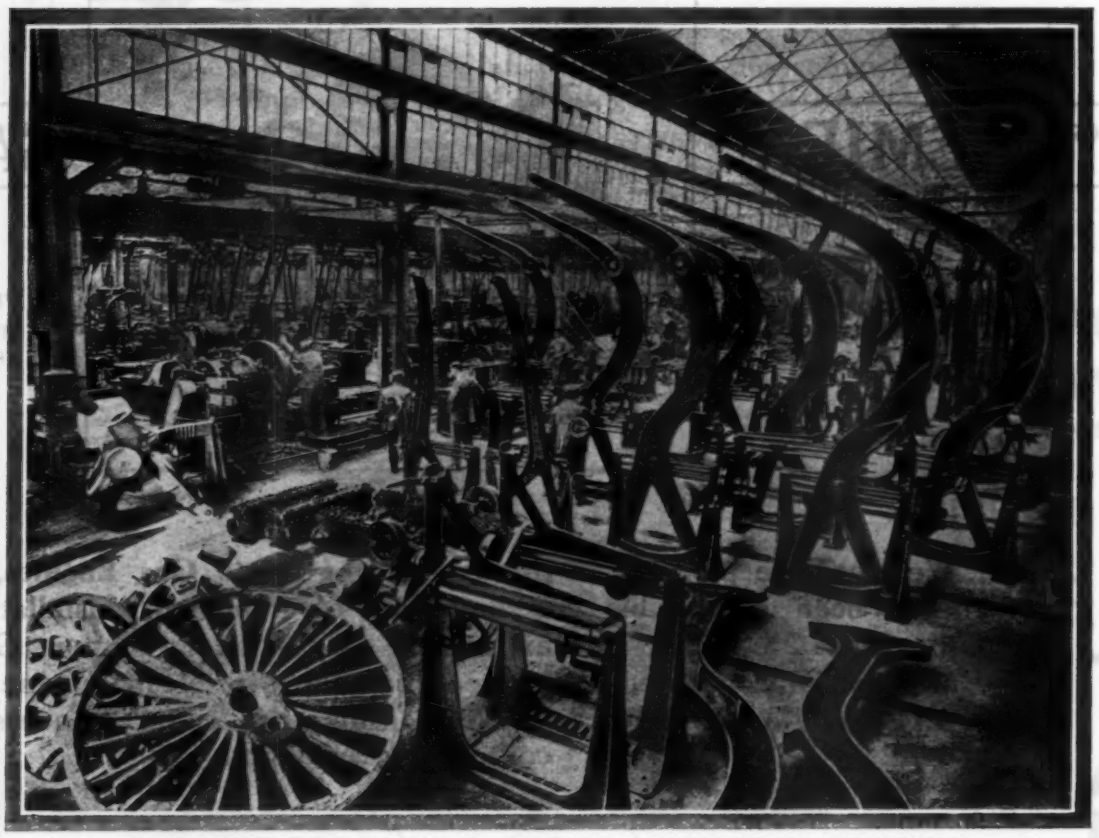
KRYN & LAHY

METAL WORKS, LTD.,

STEEL FOUNDERS AND ENGINEERS.

Manufacturers of
HIGH CLASS
Steel Castings
for all purposes.

Steel Castings can be rough or finish machined in our own Machine Shops.



LETCHWORTH,

HERTFORDSHIRE, ENGLAND.

"MARSHALL" SUPERHEATED STEAM SEMI-PORTABLE ENGINES ("Locomobiles")

Fuel Consumption 1·39 lbs. per B.H.P. per hour with Coal of 11,500 B.T. Units, Calorific value.

"Locomobiles" occupy small spaces, are thoroughly dependable, run steadily and successfully rival the economy of the Suction Gas Engine.

Apply for Illustrated Catalogue. :: **MARSHALL, SONS & COMPANY, Ltd., Engineers, GAINSBOROUGH.** :: *Mention "The Engineer."* No. 1.

ASSOCIATED BRITISH MACHINE

17, GROSVENOR GARDENS

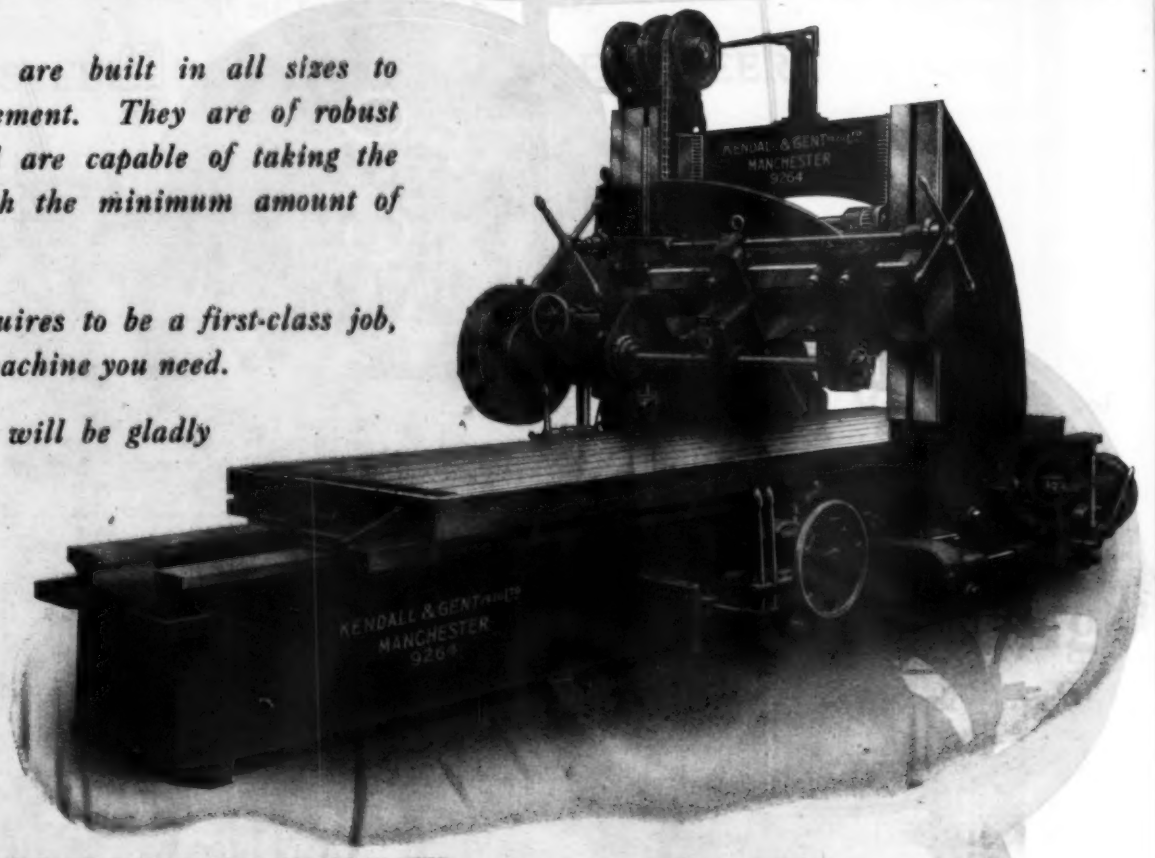
MANCHESTER - LEEDS - GLASGOW - BIRMINGHAM

THE K & G HORIZONTAL PLANO MILLING MACHINE

These machines are built in all sizes to suit any requirement. They are of robust construction and are capable of taking the heaviest cut with the minimum amount of power expended.

If your work requires to be a first-class job, then this is the machine you need.

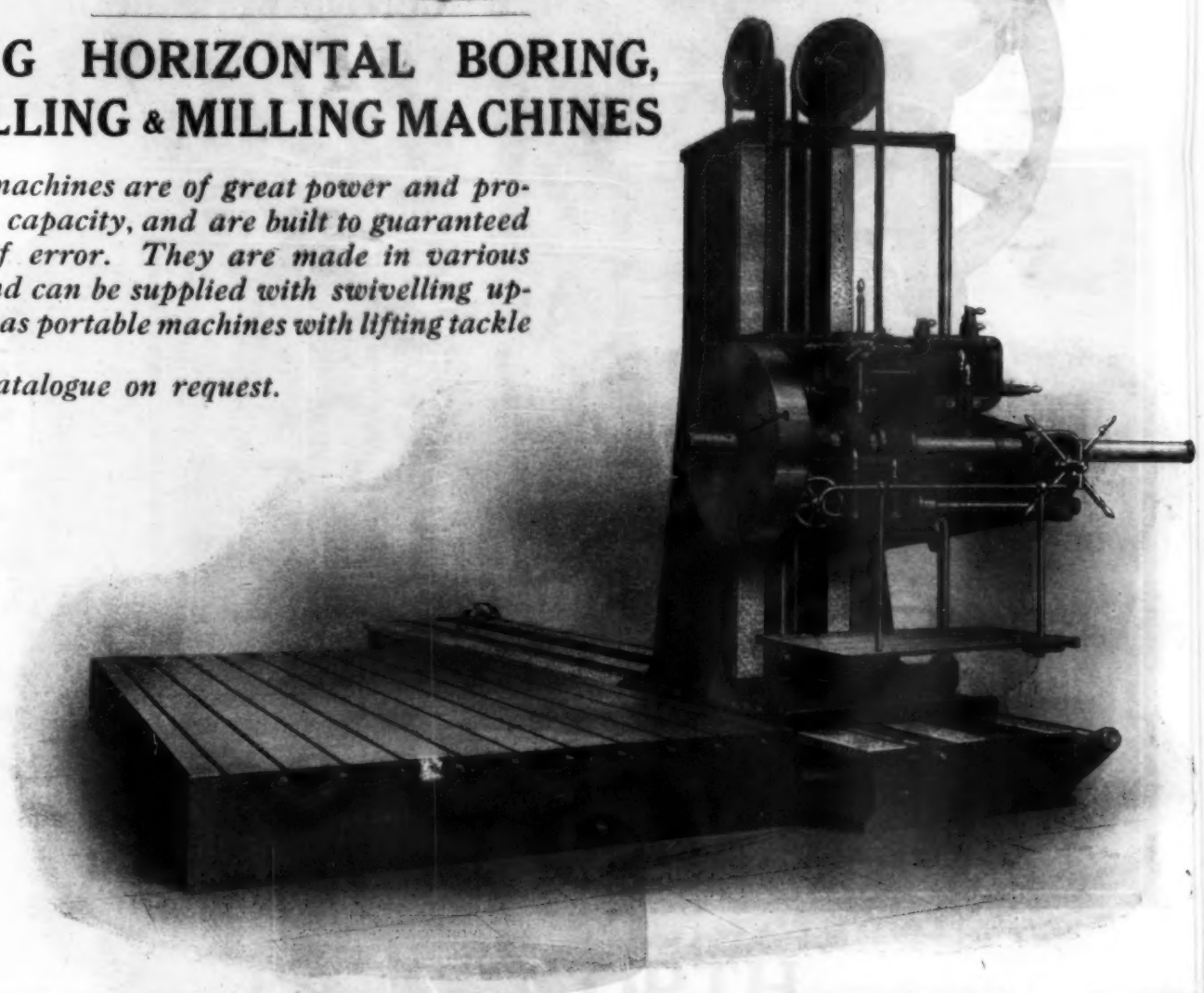
Full particulars will be gladly given on request.



K & G HORIZONTAL BORING, DRILLING & MILLING MACHINES

These machines are of great power and productive capacity, and are built to guaranteed limits of error. They are made in various sizes and can be supplied with swivelling upright or as portable machines with lifting tackle

Catalogue on request.



KENDALL & GENT (1920), LTD

VICTORIA WORKS, GORTON, MANCHESTER.

Telephone—6397 & 8 Central. Telegrams—Tools, Manchester.

TOOL MAKERS LIMITED

LONDON, S.W.1.

NEWCASTLE · PARIS · BRUSSELS · CALCUTTA

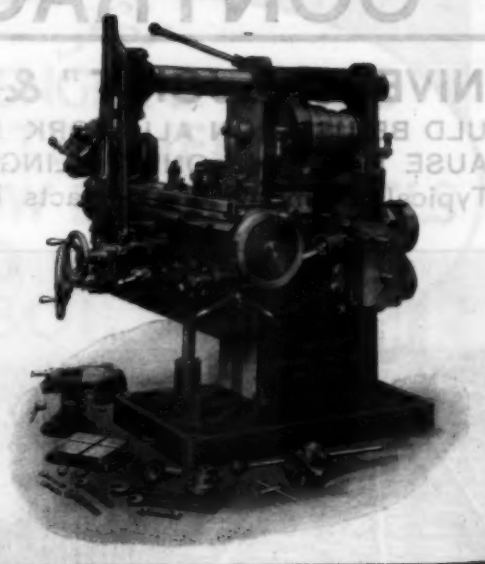
PARKSON TRADE MARK. **UNIVERSAL MILLERS** are accurately built, and subject to rigid inspection throughout construction.

They may be depended upon for any duty,—whether in **WORKSHOP or TOOLROOM.**

Publication T2 describes them.

SOLE MAKERS:

J. PARKINSON & SON, SHIPLEY.

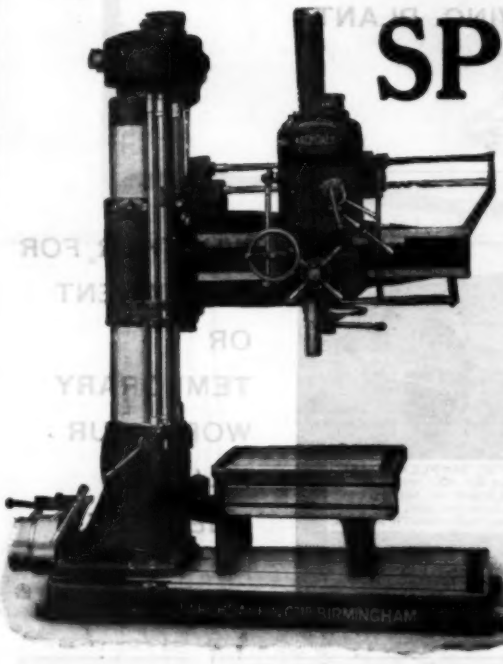


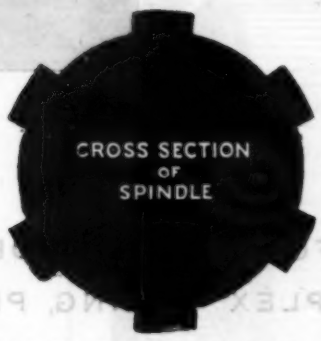
SPLINED SPINDLES

ON

ARCHDALE

4' 6" CENTRALISED CONTROL RADIAL DRILLS.





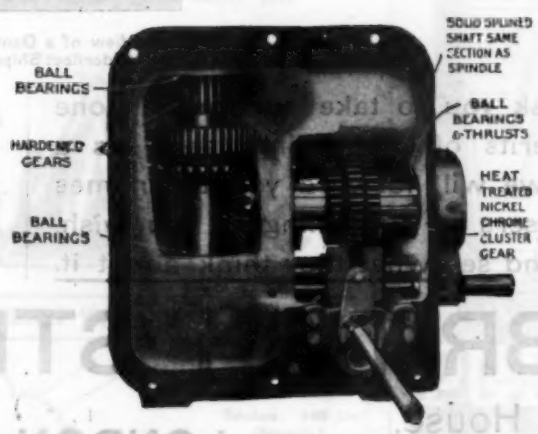
ARCHDALE RADIALS were the first machines of Centralised Control designed to be placed on the market.

ARCHDALE RADIALS were the first machines to be fitted in 1919 with the solid splined spindle (see full size section). A good advance in design enabling better performances to be secured from smaller spindles.

ARCHDALE RADIALS are still one of the few modern machine tools using solid spline shafts in the gear box.

All gears throughout the machine are hardened and heat treated. Those in the saddle being Air Hardened Nickel Chrome Steel.

INCREASE YOUR PRODUCTION BY USING ARCHDALE CENTRALISED CONTROL RADIALS.



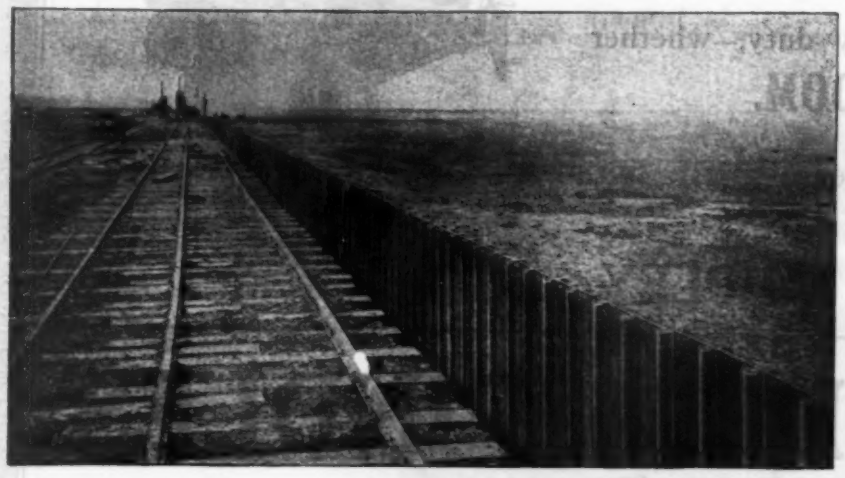
JAS. ARCHDALE & CO., LTD., LEDSAM ST., BIRMINGHAM.

Re PILE DRIVING CONTRACTS.

CONTRACTORS AND OTHERS SHOULD NOTE THAT

"UNIVERSAL-JOIST" & "SIMPLEX" STEEL SHEET PILING

SHOULD BE USED ON ALL WORK DEMANDING EXPEDITION, EFFICIENCY AND ECONOMY BECAUSE IT IS THE ONLY PILING SATISFYING ALL THESE ESSENTIALS. The following are Typical Examples of Contracts in which our Piling has been used:—



"Universal-Joist" Piling used in constructing the Wharf at Port of Richborough.

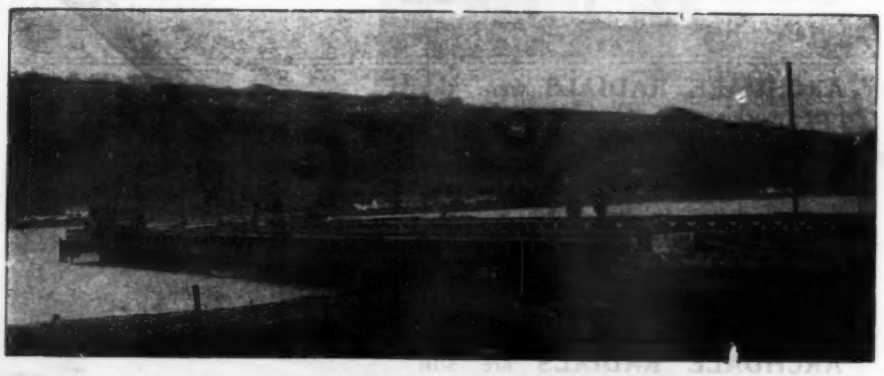
NEARLY HALF A MILE OF "UNIVERSAL-JOIST" PILING, EACH PILE OVER 35 FEET LONG, DRIVEN AS STRAIGHT AS AN ARROW BY OUR STANDARD STEAM PILE DRIVING PLANT.

BOTH SECTIONS ARE AS EASILY ADAPTED FOR CIRCULAR AS STRAIGHT WORK.

A CYLINDER OF "S" SIMPLEX STEEL SHEET PILING, 3ft 10in dia. x 45ft long (assembled) used for permanent work in Jetty construction at the KILLINDINI Harbour Works, SOUTH AFRICA.

WHETHER FOR PERMANENT OR TEMPORARY WORK OUR PILING IS THE BEST.

800 FOOT DAM, MADE WITH "SIMPLEX" PILING, PROVED ABSOLUTELY WATERTIGHT.



View of a Dam for a Slipway in a New Shipyard at Larne, being constructed by the Olderfleet Shipbuilding and Engineering Co., Ltd., in which "Simplex" Piling was used.

We do not ask you to take our word alone as to the merits of our Piling; send us a request, and we will forward you the names of as many users of our Piling as you wish. Go to them and see what they think about it.

It does not matter whether you live in London or Timbuctoo, or any other civilised part of the Globe—our Piling is in use the world over and we can send you a user's name within a reasonable distance.

The BRITISH STEEL PILING Co.

Dock House, Billiter Street, LONDON, E.C. 3. Works: Claydon, Suffolk.

YARROW

& CO (1922) LTD GLASGOW

for

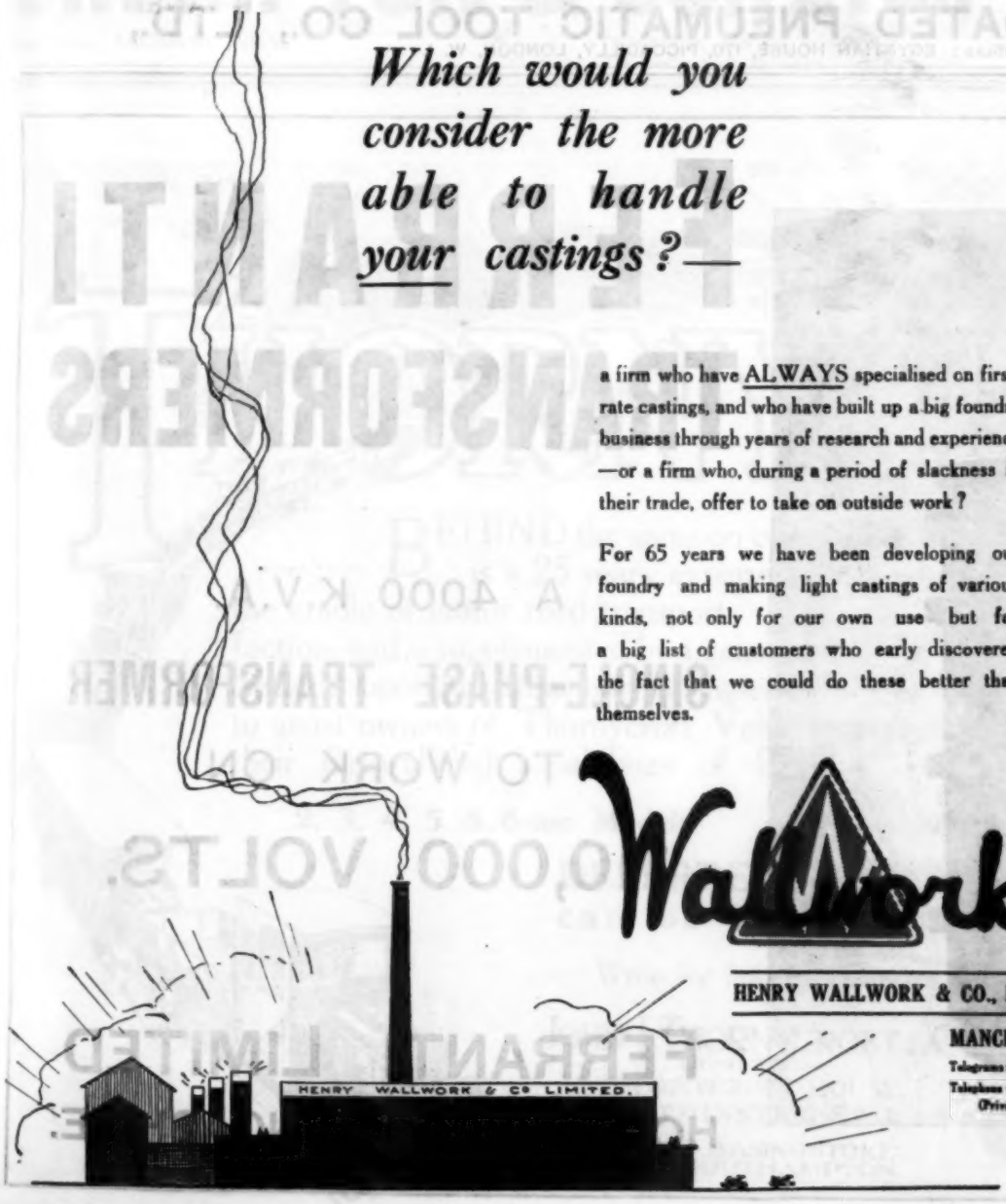
PASSENGER & CARGO STEAMERS
SHALLOW DRAFT VESSELS
LAND & MARINE BOILERS

Which would you consider the more able to handle your castings?—

a firm who have ALWAYS specialised on first-rate castings, and who have built up a big foundry business through years of research and experience —or a firm who, during a period of slackness in their trade, offer to take on outside work?

For 65 years we have been developing our foundry and making light castings of various kinds, not only for our own use but for a big list of customers who early discovered the fact that we could do these better than themselves.

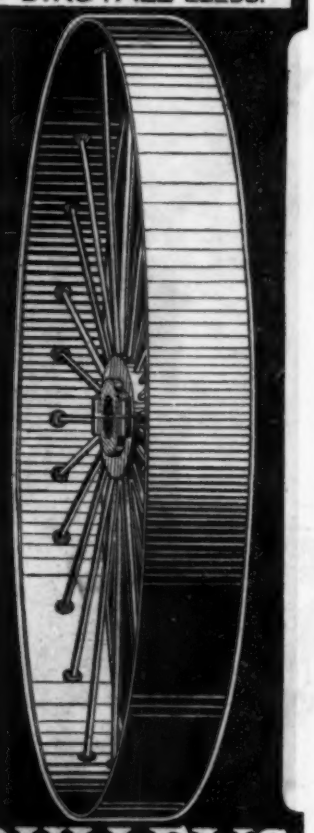
Wallwork



HENRY WALLWORK & CO., LIMITED
MANCHESTER.
Telegrams: "Foundry."
Telephone: 8400 City (Private Ex.)

DOUGLAS, LAWSON & COMPANY.

BIRSTALL NR LEEDS.



PULLEYS

WROUGHT IRON

A SOLE SPECIALITY

TELEGRAMS:—PULLEYS, BIRSTALL
TELEPHONE—135 BATLEY.

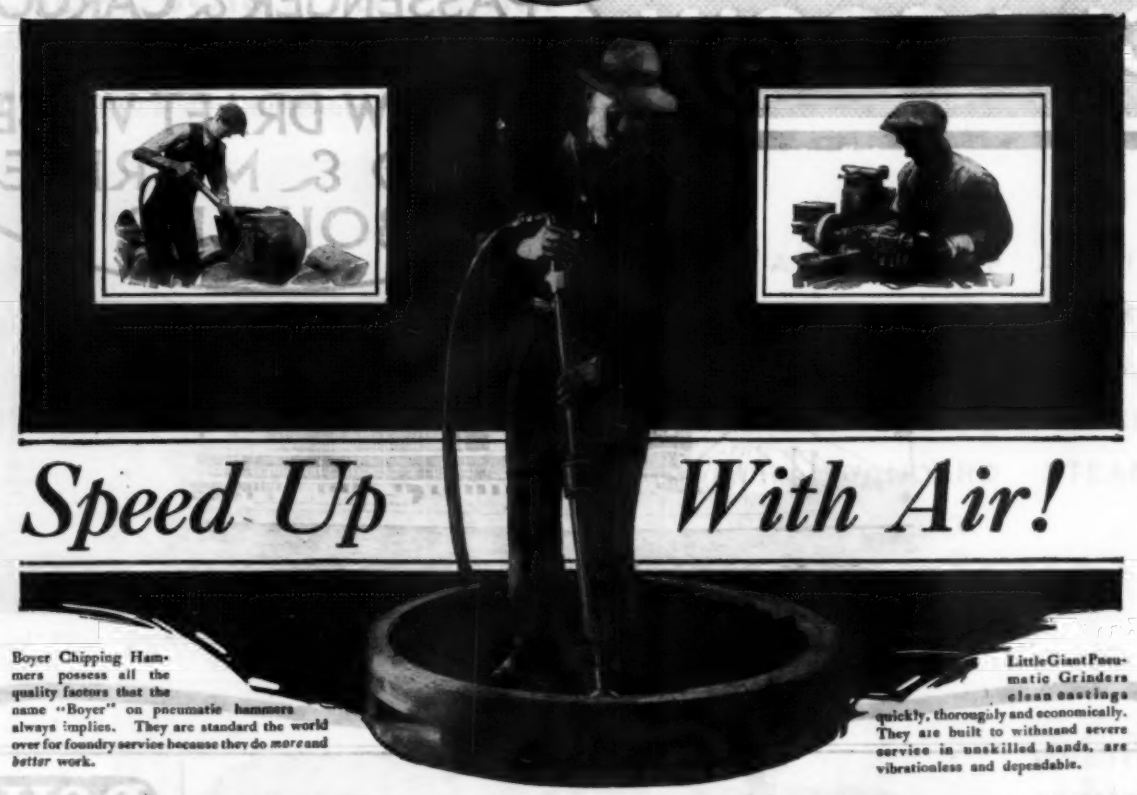
BOYER HAMMERS.

And Sand Rammers for Foundry Purposes.

CONSOLIDATED PNEUMATIC

Tel. Address
CAULKING, PICCY, LONDON.

Tel. No.:
GERRARD 9215.



Suppliers of

AIR COMPRESSORS (Stationary and Portable)
PNEUMATIC TOOLS.
ELECTRIC TOOLS.
ELECTRIC RIVET HEATER.
ELECTRIC TYRE HEATER.
THE WAYNE SELF-WINDING ELECTRIC CABLE REEL.
ELECTRIC WELDING PLANTS.

Suppliers of

WELDRIC'S PATENT ELECTRODES.
ROCK DRILLS (Hand and Tripod Types).
SPEED RECORDERS (For Locomotives and Trams).
OIL ENGINES.
VACUUM PUMPS.
PNEUMATIC PAINT SPRAYING EQUIPMENTS.
DUFF JACKS AND TRENCH BRACES.

Speed Up With Air!

Write for Particulars.

Write for Particulars.

Boyer Chipping Hammers possess all the quality factors that the name "Boyer" on pneumatic hammers always implies. They are standard the world over for foundry service because they do *more* and *better* work.

Little Giant Pneumatic Grinders clean castings quickly, thoroughly and economically. They are built to withstand severe service in unskilled hands, are vibrationless and dependable.

WORKS: FRASERBURGH, SCOTLAND.

BRANCHES ALL OVER THE WORLD.

THE CONSOLIDATED PNEUMATIC TOOL CO., LTD.,

Head Offices: EGYPTIAN HOUSE, 170, PICCADILLY, LONDON, W. 1.

FERRANTI TRANSFORMERS

A 4000 K.V.A.

SINGLE-PHASE TRANSFORMER

TO WORK ON

110,000 VOLTS.

FERRANTI LIMITED

HOLLINWOOD, LANCASHIRE.

UNITY POWER FACTOR REPRESENTS MAXIMUM ECONOMY.

CROMPTON AUTO-SYNCHRONOUS MOTORS

Can be supplied in suitable form for any Industrial Service, either to operate at Unity Power Factor or to take Leading Current and Correct or Improve the Power Factor of Existing Loads.

SIMPLEST TYPE CONSTRUCTED.

ADVANTAGES.

Start against overload.

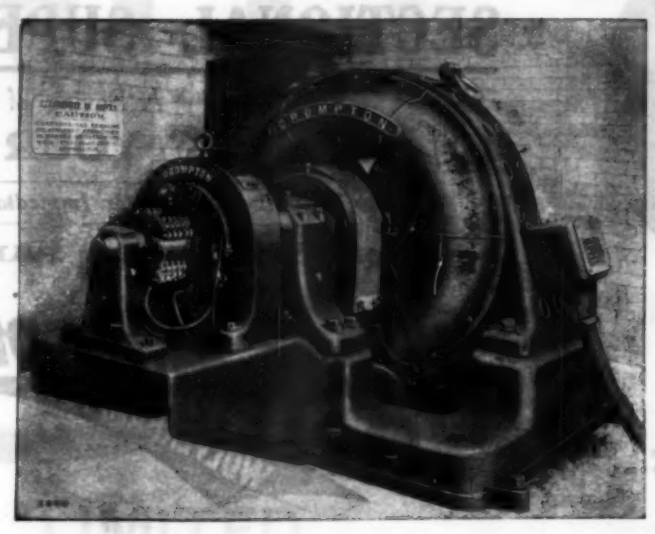
Require plain rotor starter and ordinary Stator Switch only.

Excitation Circuit always closed.

No skilled operators required.

Self-synchronizing.

May we send you complete lists of our manufactures?



SYNCHRONOUS MOTOR DRIVING FAN.

ALTERNATORS,

DYNAMOS,

MOTORS,

CONVERTERS,

SWITCHGEAR,

INSTRUMENTS,

&c.

CROMPTON & CO., LTD., Chelmsford, England

Works Telegrams: "CROMPTON CHELMSFORD."
Telephone: 161 Chelmsford.

Regd. Office: SALISBURY HOUSE.

Telegrams: "CROMPTON, PHONE, LONDON."
Telephones: 4734 London Wall; 86 London Trunk.

THORNYCROFT

BEHIND the name on every Thornycroft Vehicle is a 25 years' experience in a works which have been the cradle of motor road transport. It is your assurance of 100% Satisfaction, and is supplemented by a generous and far-reaching organisation of Service, operating from our Basingstoke Works and Provincial Depots, to assist owners of Thornycroft Vehicles to secure the full measure of their unparalleled capabilities of Reliable and Economical running.

2, 3, 4, 5 & 6-ton Models. **Catalogue on request.**

DEFERRED TERMS can be arranged.

Write for full particulars.

JOHN I. THORNYCROFT & Co
LIMITED
THORNYCROFT HOUSE,
WESTMINSTER, S.W.1.

Works - BASINGSTOKE AND SOUTHAMPTON

SUPERHEATERS.

STEAM PLANT ECONOMY.

Any tube easily removed and replaced in a few minutes without disturbing the brickwork or header.

Equip your Boilers with the

"THOMPSON" PATENT SECTIONAL SUPERHEATER.

A Saving of

10% to 20% OF YOUR COAL BILL.

Standard Sizes for Immediate Delivery.

ASK FOR FULL PARTICULARS.

JOHN Thompson WOLVERHAMPTON

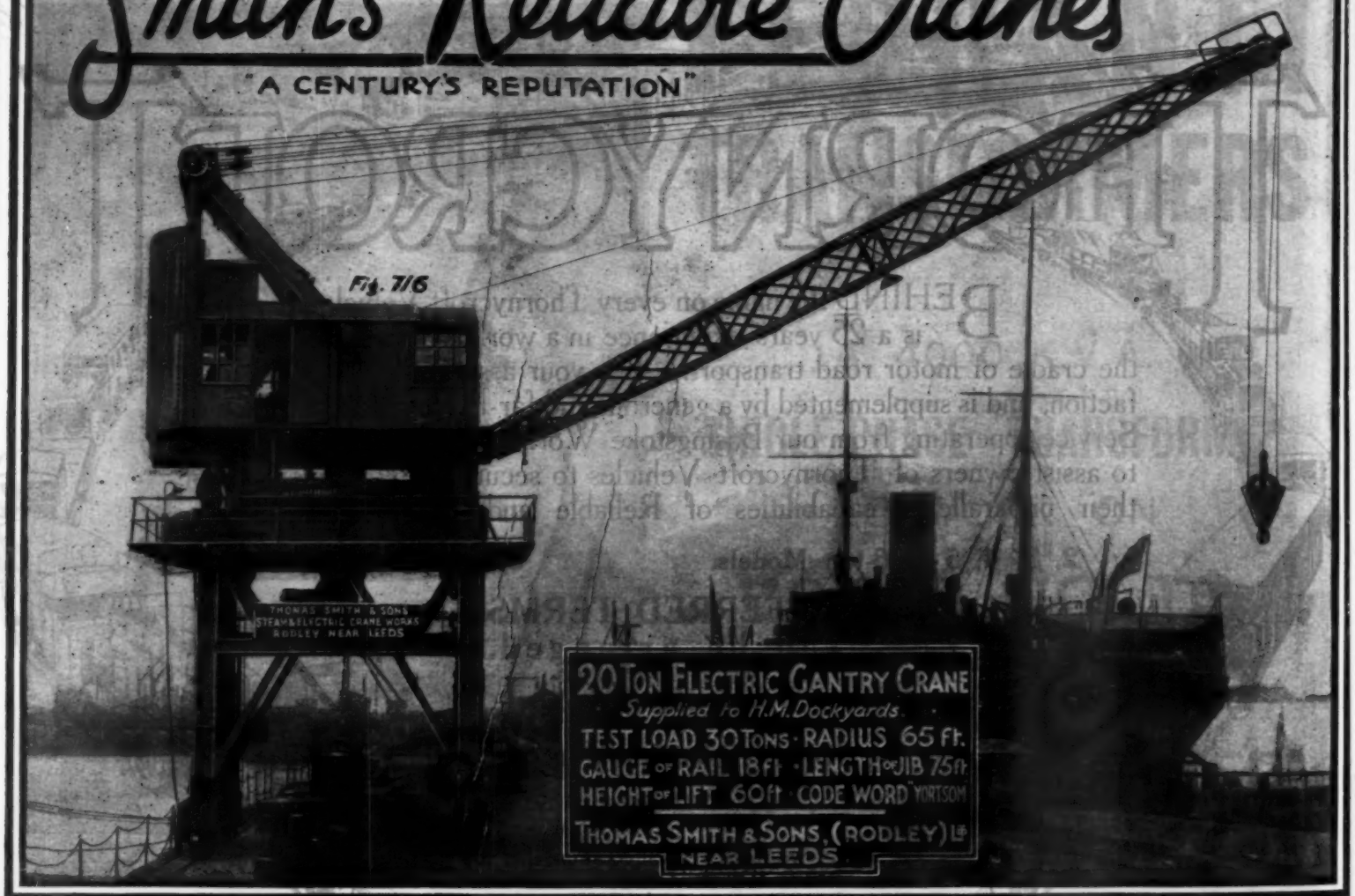
Also Proprietors of "McPHAIL & SIMPSON" SUPERHEATER.

ALL TYPES **BOILERS** WATER TUBE BOILERS.

COMPLETE PIPEWORK INSTALLATIONS.

Smith's Reliable Cranes

"A CENTURY'S REPUTATION"



20 TON ELECTRIC GANTRY CRANE
Supplied to H.M. Dockyards.
TEST LOAD 30 TONS · RADIUS 65 ft.
GAUGE OF RAIL 18 ft · LENGTH OF JIB 75 ft
HEIGHT OF LIFT 60 ft · CODE WORD YORTSOM

THOMAS SMITH & SONS, (RODLEY) Ltd
NEAR LEEDS

ROYCE

Electric

CRANES

CAPSTANS

DYNAMOS

AND

MOTORS

Of Highest Quality

AND

For ALL Purposes.

ROYCE LIMITED,

Trafford Park, Manchester.

Cablegrams:—Royces Manchester England.
Telegrams:—Royces Manchester.
Telephones:—660, 661, 662 Trafford Park.

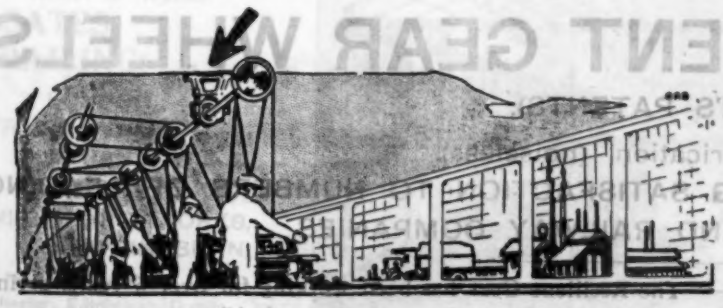
Perfect your Works Machinery.

WORKS organisation is a question of the efficiency of detail. Be sure that you are obtaining every ounce of power from your machinery. Ball Bearings have entirely superseded old-fashioned plain Bearings in all up-to-date plants.

The installation of Ball Bearings wherever possible is true economy, and no Bearings will render you better service than **N.K.A. BEARINGS.** They have proved themselves in service to withstand the hardest tests and to give you care-free, year-after-year service.

N.K.A. Self-aligning Plummer Blocks.
N.K.A. Self-aligning Hanging Bearings.
N.K.A. Housings for Truck Bearings.

Our technical department will gladly advise Works Managers upon the most suitable Bearings for any specific requirement, etc.



NORTHERN BALL BEARINGS
LIMITED

115, Great Portland Street, W.1.

BRANCHES at Coventry, Lincoln, Manchester, Glasgow, Cardiff, Bedford, Leeds and Dublin.

ROBERT STEPHENSON & CO. LTD., LOCOMOTIVE BUILDERS, DARLINGTON.

Telegrams: Rocket, Darlington. Telephone: 2700.
ESTABLISHED AT NEWCASTLE 1823.

Engineering Standards, A B C (5th Ed.), Engineering Telegraph (2nd Ed.), and Kendall's 12-figure Cypher.
NEW WORKS OPENED AT DARLINGTON 1902.

LONDON OFFICE: 17, Victoria Street, Westminster, S.W.1.
Telegrams: Altiscope, London. Telephone: 650 Victoria.

LOCOMOTIVES

OF THE HIGHEST CLASS UP TO ANY SIZE AND CAPACITY.

SPECIAL LOCOMOTIVES — SINGLE EXPANSION, ARTICULATED or other types with FLEXIBLE WHEEL BASE, TO SUIT ANY GAUGE OF RAIL AND CONDITIONS OF SERVICE.

KEYS, PINS, etc. for Engine Work.

Mills Keys, Pins, Cotters, &c., are standard in progressive engine shops. They are all made true to size and are well finished.

We carry all sizes in stock and can deliver NOW.

Write for our lists.

Sears of
Jas. Mills, Limited,
Bredbury, Nr. Stockport.

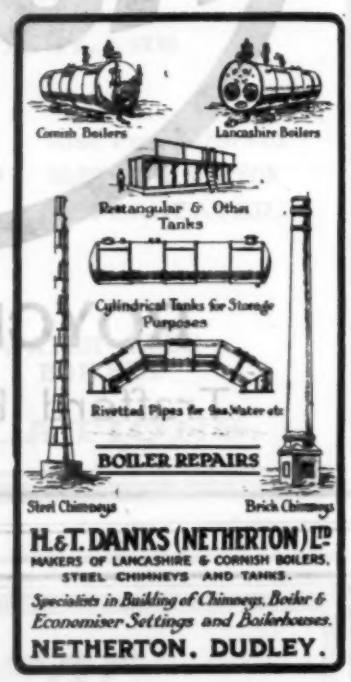
The number of times you have to repack a stuffing box depends upon the kind of packing you use.
You don't have to repack so often when you use

"PALMETTO" PACKING

because it is made to give long service, which means economy.

Let us send you a free working sample to test.

W. F. JOHNSON & CO., Agents,
113, Clerkenwell Road, LONDON, E.C.



H. & T. DANKS (NETHERTON) LTD.
MAKERS OF LANCASHIRE & CORNISH BOILERS, STEEL CHIMNEYS AND TANKS.
Specialists in Building of Chimneys, Boiler & Economiser Settings and Boilerhouses.
NETHERTON, DUDLEY.

LANCASHIRE, CORNISH & MULTITUBULAR

BOILERS.

WM. WILSON and CO.,
Lilybank Boiler Works, Glasgow.

HENRY WOOD & CO., Ltd.,
SALTNEY, near CHESTER,
Chain & Anchor Manufacturers,
Large Moorings a Speciality.
FORGINGS, CRANE CHAIN, CHAIN SLINGS, &c

McLACHLAN & CO., LTD., DARLINGTON.

SOLE MANUFACTURERS OF THE

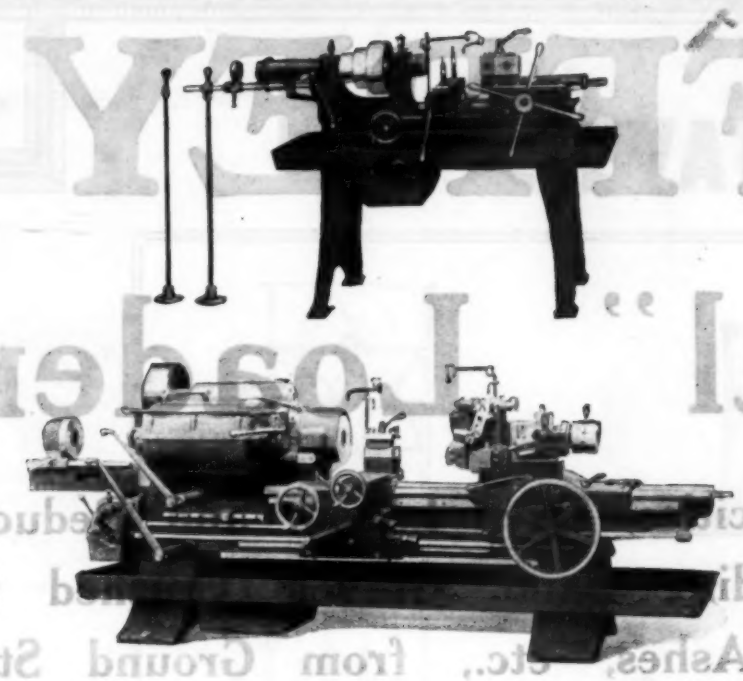
ALL-STEEL RESILIENT GEAR WHEELS

(SEYMOUR'S PATENTS).

Automatic Lubrication (noiseless).

UNAFFECTED BY STEAM OR OIL. GIVING SATISFACTION TO NUMBERS OF LEADING ENGINEERING FIRMS AND RAILWAY COMPANIES.

AN APPRECIATION FROM A NEWCASTLE FIRM:—"The Resilient Gear has been working for over 6 years, giving entire satisfaction, the life of a Rawhide pinion in use previously being only 6 months!"



Warner & Swasey

TURRET SCREW MACHINES

and

TURRET LATHES

INCREASE OUTPUT

Send us your blue prints,
perhaps we can help you.

CHARLES CHURCHILL & CO·LTD

9-15 LEONARD STREET LONDON E·C·2

BIRMINGHAM · MANCHESTER · GLASGOW · LEEDS
SHEFFIELD · BRISTOL · LEICESTER · NEWCASTLE-on-TYNE

W.S.218

ARMSTRONGS & MAIN, Ltd.,

(FORMERLY A. & J. MAIN & CO., LTD.)

STEEL BUILDINGS.

BRIDGES.
ROOFING.
TRUSSES.
GIRDERS.
FENCING
IRON & WIRE.
GATES.
RAILING.

LONDON:
AUSTRALIA HOUSE,
STRAND, W.C. 2.

GLASGOW:
GERMISTON IRONWORKS,
SPRINGBURN.

Also at Newcastle-on-Tyne, Manchester, Edinburgh, Dublin, Bombay, Calcutta, Cape Town and Johannesburg

WELLS' "LIGHTNING" PAINTER

(Wallwork & Wells' Patents).

PAINTING BY MACHINE.

Great Saving in Time, Paint & Labour.

PAINTING SPEED—8 sq. yds. a minute.

The paint is sprayed evenly and continuously through a flexible tube and nozzle, supplied with compressed air, either from existing air main or from our special Compressors.

Large and Small Plants according to requirements.

WELLS "LIGHTNING" LIME & COLOUR WASHER.

(Wallwork & Wells' Patents).

Over 2,000 Sold.

A GREAT SAVING OF TIME, LABOUR AND MONEY.

A variety of patterns stocked.

SAVES ITS COST IN A FEW DAYS

Lime Whiting or Cold Water Paints

applied at a speed of from 10 to 20 square yards per minute in a manner superior to brushwork. One coat with the machine on rough surfaces is equal to two applied with brushes.

WELLS' WASTE OIL FILTERS,

AND WATER SEPARATORS.

Fitted with Patent Sight-Feed Syphons.

Over 25,000 Sold.

Invaluable to ALL users of Machinery, Steam, Oil or Gas Engines.

Supplied to the Principal Governments, Electric Light Installations, Corporations, Water Companies, Engineers, Garages, &c.

Money Savers to any Users of Machinery.

Put first cost in a short time as Dirtied Oil, which has hitherto been thrown away, can be filtered and used again & again

Larger Sizes made to order, capable of dealing with 250 to 500 Gallons Oil per week.

A. C. WELLS & CO.,

101, Midland Road, St. Pancras, LONDON, N.W.1.

Works: Carnarvon St., MANCHESTER

JEFFREY

"Radial" Loaders

Increase Capacities, Save Labour and Reduce the Cost of Loading Sand, Gravel, Crushed Stone, Coke, Coal, Ashes, etc., from Ground Storage.

Type "G" Radial Loader.

Type "K" Radial Loader.

Three Wheel Support

enables the machine to turn a complete circle with either drive wheel as a centre.

Dig into the pile 8 to 10 feet, requiring no hand shoveling or mechanical devices to bring material to the buckets.

Built to stand the strain of the most severe service.

Radial Loaders are made in Two Sizes:

Type "K" has a capacity of 1 cubic yard per minute.

Type "G" loads 1½ to 2 cubic yards per minute.

Write for Catalogues No. 288 and 309, fully illustrating and describing them.

THE JEFFREY MANUFACTURING COMPANY,

Represented in Great Britain by

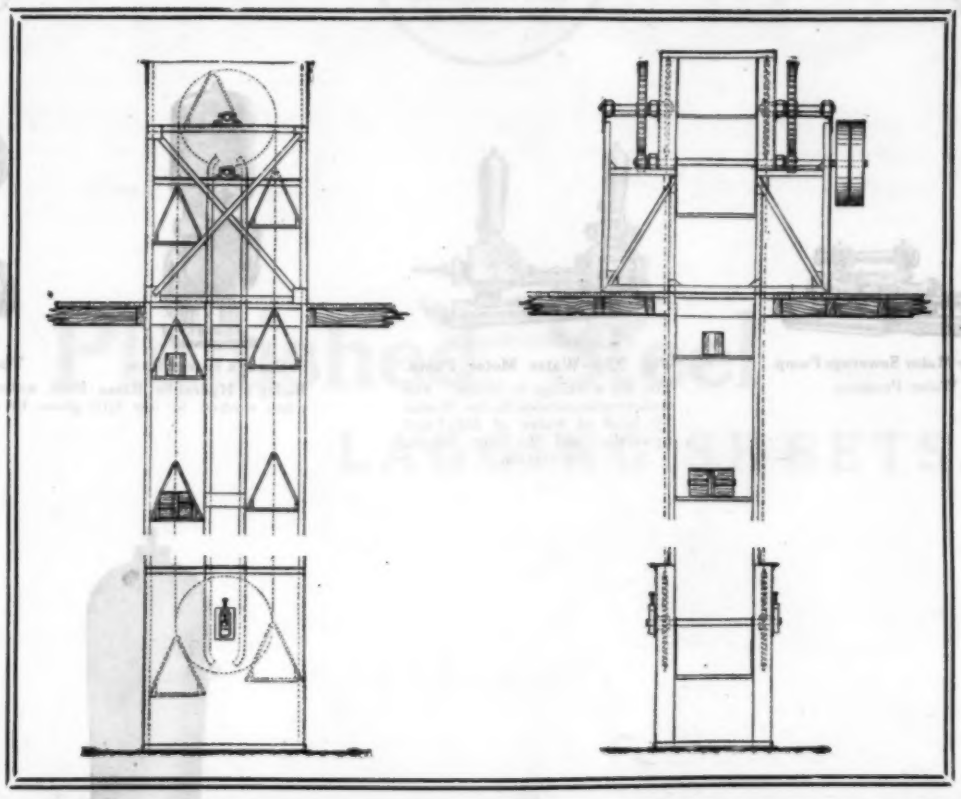
HUGH WOOD & CO., LTD.,

DEPT. E. 65, Fenchurch Street, London, E.C. 3.

Telegrams: Hewod, Fen., London. Telephone No.: Avenue 1645.

HEAD OFFICE: NEWCASTLE-ON-TYNE. And at MANCHESTER & CARDIFF.

BOX ELEVATORS



ELEVATORS.

In this advertisement we appeal especially to those firms occupying buildings of more than one storey in height, such as large stores, warehouses and manufacturing concerns as well. The most economical method of handling BOXES, CASES, BALES, BUNDLES OR TRAYS of material is of the greatest importance. We show a photograph of a typical swing tray elevator and an idea of the general lay-out. Elevators of this kind are particularly suitable for the work referred to above. They can be used in buildings of two or ten stories with advantage for all sizes of packages not too heavy for loading by hand. The cost of operation and upkeep is small and there is nothing to get out of order. For instance, a box left on the elevator will keep going round without harm until removed. We can supply COMPLETE Installations or all necessary parts if customers prefer to make their own frame work, which can in many cases be constructed in timber as shown in the photograph.

BAGSHAWE

DUNSTABLE. & CO., LTD. 912

Bailey's

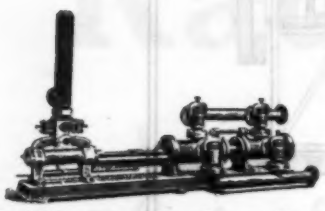


Fig. 6038.—Water Motor Sewerage Pump.
Driven by Water Pressure.

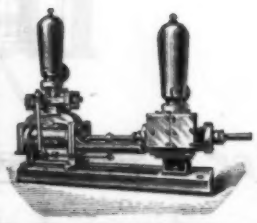
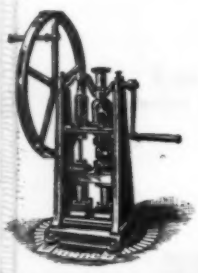


Fig 33.—Water Motor Pump.
For dip workings in Mines. For waterworks, estates, farms. Works by head of water of 30ft. and upwards, and to any height deliveries.

de Coeur's Patent Ram.

The "Caliban" Ram.

Bailey's Hydraulic Rams force water to a great height when worked by low falls given by streams and brooks.



The "Challenger" Hand Pump for shallow or deep wells.

Fig. 160. — Ram Pump. All types — vertical or horizontal, with 1, 2 or 3 rams, and for any pressure. For water, oils, acids, etc.

The "Aqua-Thruster" Pulsating Steam Pump

For contractors, mines, mills and works, pumping mud, slurry, sewage, and for coal washing.

THE SIMPLEST STEAM PUMP. REQUIRES NO SKILLED ATTENTION.

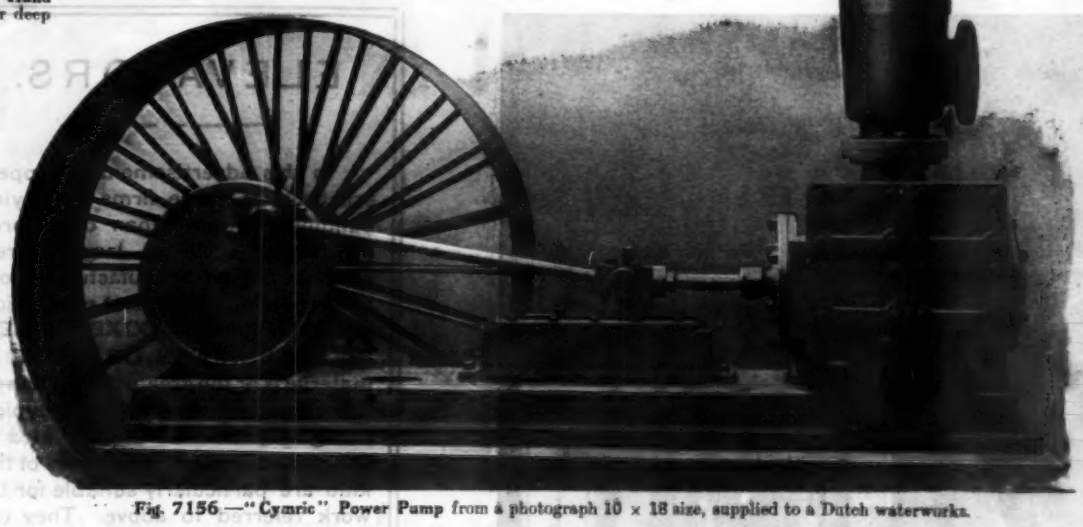
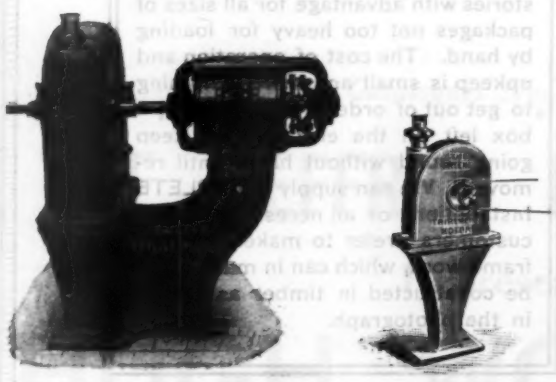


Fig. 7156.—"Cymric" Power Pump from a photograph 10 × 18 size, supplied to a Dutch waterworks.



Bailey's "Thirlmere" Water Motors for heads of 30ft. and upwards. For electric lighting, driving hair-brushing, bottle-washing, coffee-grinding machines, lathes and other tools, etc.

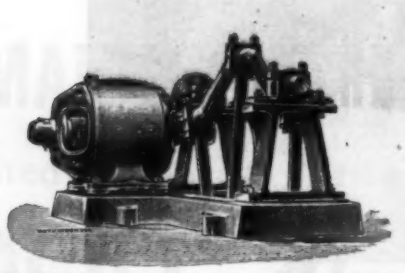
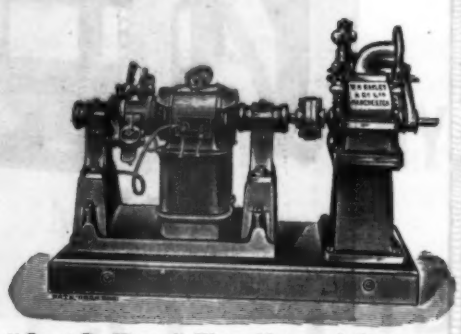


Fig. 7071.—Electric Pump Gear for Deep Wells.



"Count De Vismes" Water Motor and Dynamo for electric lighting, charging accumulators, etc.

SOLE MANUFACTURERS:

Sir W. H. Bailey & Co Ltd

ALBION WORKS, SALFORD, MANCHESTER.

"SPEEDICUT" HIGH-SPEED STEEL.

"SPEEDICUT" HIGH-SPEED DRILLS, CENTRE DRILLS, MILLING CUTTERS REAMERS, &c.

"INSTO" INSERTED TOOTH SAWS.

Planished Steel
LAGGING SHEETS.

BEST CAST STEEL FILES.

5% Nickel Steel
HIGH TENSILE SHEETS.

FIRTH'S STAINLESS STEELS.

Carbon Steel Sheets
TO SPECIFICATION S 3.

THOS. FIRTH & SONS, LTD.,
SHEFFIELD.

STEEL CASTINGS FOR ALL PURPOSES

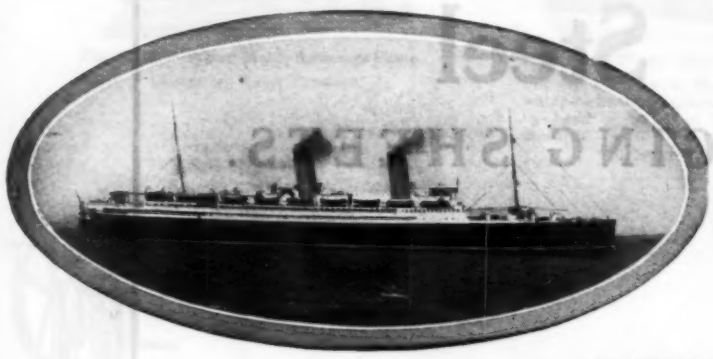
STEEL FORGINGS FOR ALL PURPOSES

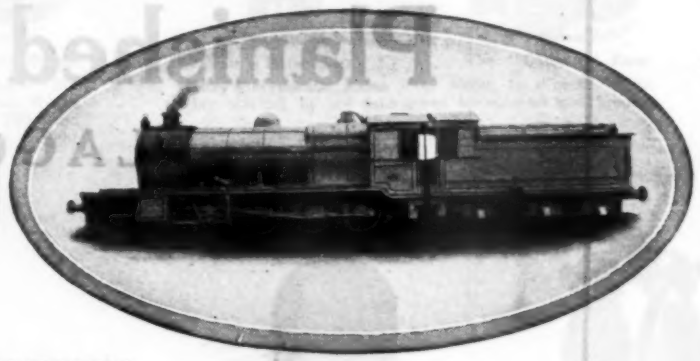
STEEL SHEETS.

INTENSIVE PRODUCTION

Devoted, Particularly, to Accelerating Better Transport Facilities

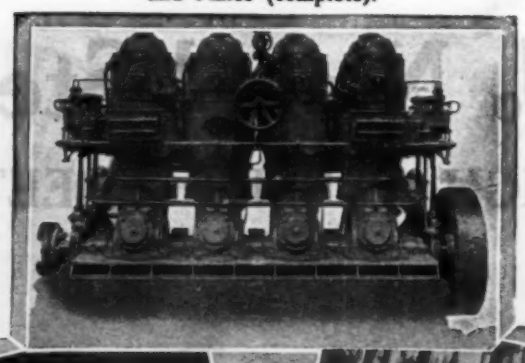
The rapid conversion by Wm. BEARDMORE & Co., Ltd., of eight distinct works from War to Peace Production, embracing over 42,000 employees, has been a noteworthy accomplishment. The success that has attended this gigantic undertaking is attributable to the loyalty of the staff and workers, augmented by the fact that the firm are, to a great extent, dependent on their *own* works only for materials for their finished products.





LOCOMOTIVES ROLLING STOCK

Tyres and Axles. Wheels and Axles (complete).

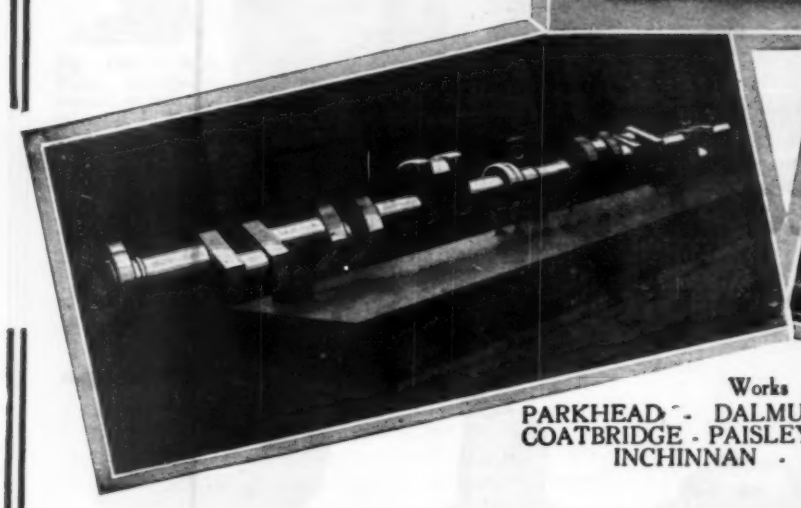


STEEL FORGINGS AND CASTINGS

Sheets, Ship and Boiler Plates and Sections, Lap-welded Furnaces (corrugated or plain), Pressed Steel Frames for Motor Cars.

MAIL STEAMERS CARGO VESSELS

Airships, Aeroplanes, Steam, Turbo, Semi-Diesel and Beardmore-Tosi Diesel Engines, Aero Engines, Motor Cars.



Works at
PARKHEAD - DALMUIR - MOSSEND
COATBRIDGE - PAISLEY - ANNIESLAND
INCHINNAN - AIRDRIE.

WILLIAM
BEARDMORE
AND COMPANY LIMITED

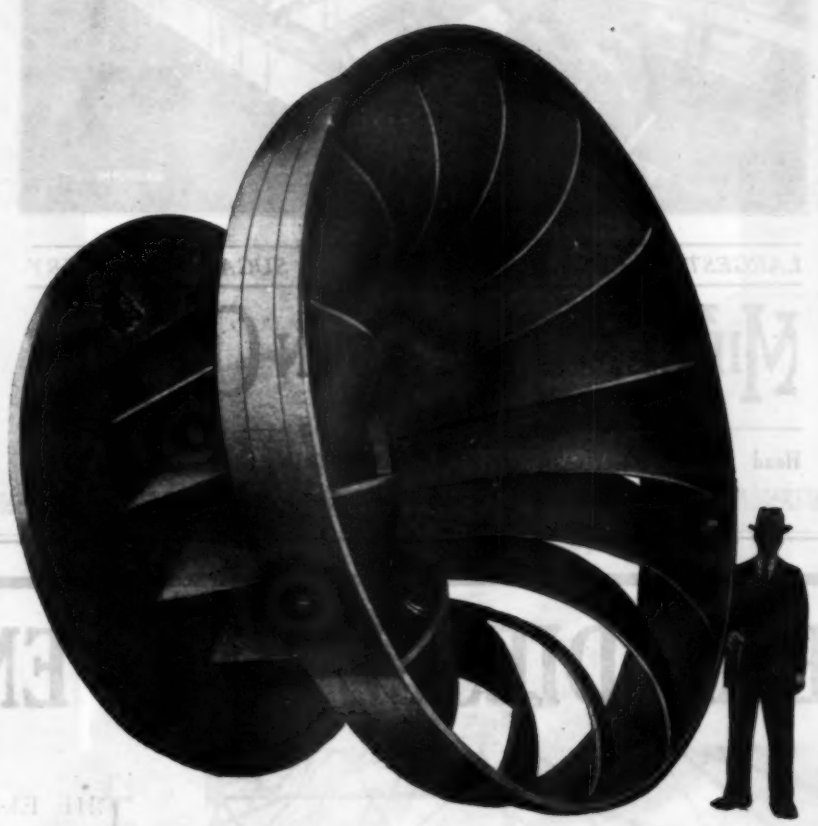
STEEL MANUFACTURERS : FORGE MASTERS
SHIPBUILDERS — ENGINEERS

GLASGOW

BOVING & Co., Ltd.,

Manufacturers of

Hydro-Electric Equipment, Water Turbines, Pipe Lines, Pulp and Paper Making Machinery.



Runner for 7700 H.P. Spiral Casing Type Water Turbine.
This is the Largest Steel Water Wheel ever cast in one piece.

When considering the installation of modern water power plant, send your enquiries to Boving & Co., who specialise in the design and construction of this machinery, and are pioneers for this class of work.

Investigation of schemes and manufacture of complete equipment carried out for any part of the world.

HEAD OFFICE:
Dept. 4,
56, KINGSWAY, LONDON, W.C. 2.
Telephone: HOLBORN 6420 (3 Lines).
Telegrams: JENORTEN, PHONE, LONDON.

WORKS:
STOKE-ON-TRENT, STAFFS.

BOVING AND Co LIMITED

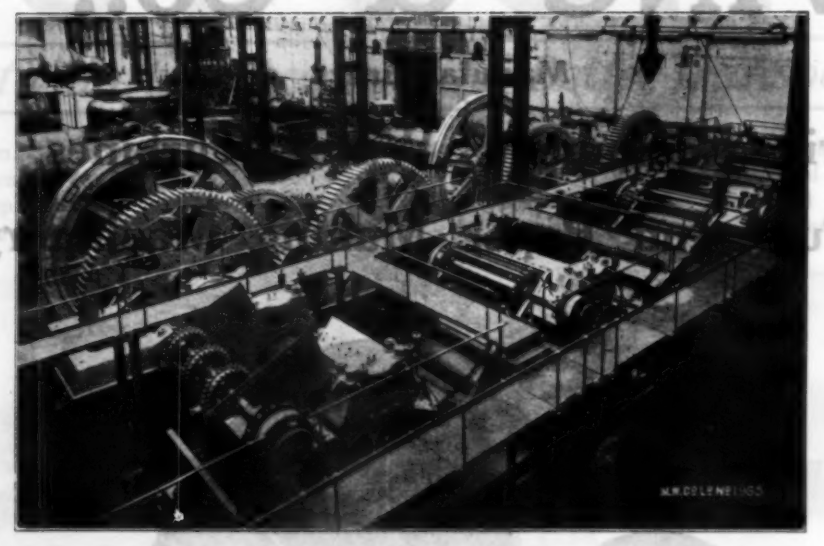
FOREIGN BRANCHES:
FRANCE: 68, Rue Caumartin, Paris.
JAPAN: No. 1, Yaeso Cho, I-chome, Tokio.
AUSTRALASIA: Bank of N.S.W. Chambers, Lambton Quay, Wellington, N.Z.
S. AMERICA: With Walter & Co., 65, Rua General Camara, Rio de Janeiro.
CANADA: Boving Hydraulic & Engineering Co., Ltd., Lindsay, Ont.
Representatives in all parts of the world.

MIRRLEES SUGAR MACHINERY

Modern Design.

Reliable Construction.

Efficient Operation.



Complete Equipments for Sugar Factories.

Existing Factories Modernised.

LARGEST MAKERS IN THE WORLD OF SUGAR MACHINERY

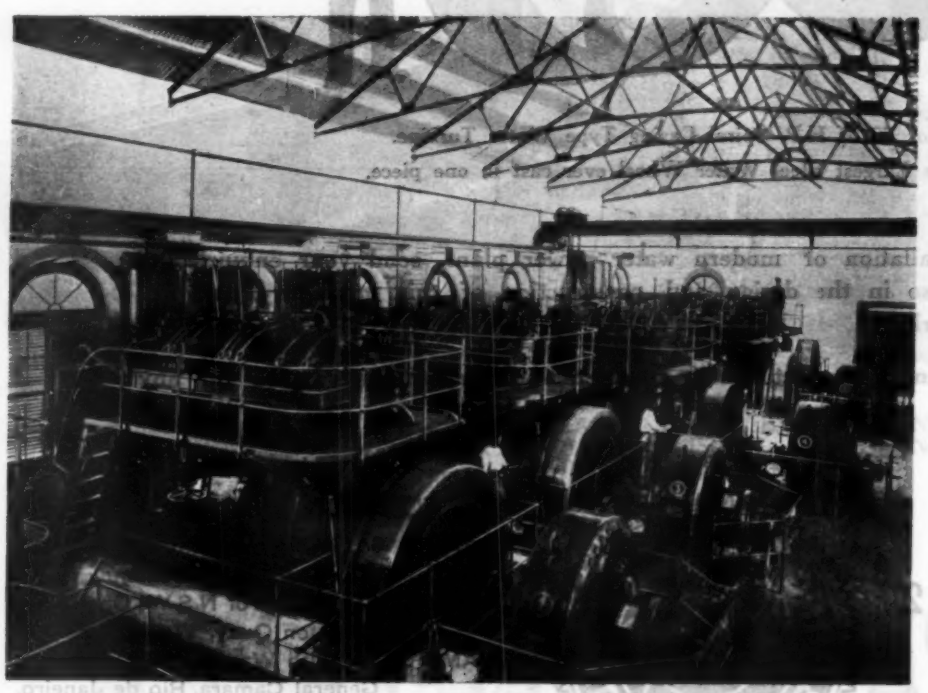
THE MIRRLEES WATSON COMPANY LTD.

ENGINEERS

Head Office and Works: SCOTLAND ST., GLASGOW.

117

MIRRLEES - DIESEL OIL ENGINES.



THE Electric Power Company, the interior of whose station is illustrated herewith, commenced supply in 1915 with three Mirrlees-Diesel Engines—one of 100 b.h.p. and two of 240 b.h.p. each. Since then four Mirrlees engines, each of 320 b.h.p., have been added, and the illustration shows the present appearance of the engine-room.

So successful has this company been, that further extensions have now been found necessary, and we have recently received an order for two additional engines, each of 750 b h.p.

MIRRLEES, BICKERTON & DAY, LTD.,

LONDON OFFICE:
MIRRLEES HOUSE,
GROSVENOR GARDENS, S.W. 1.

HAZEL GROVE, nr. STOCKPORT.

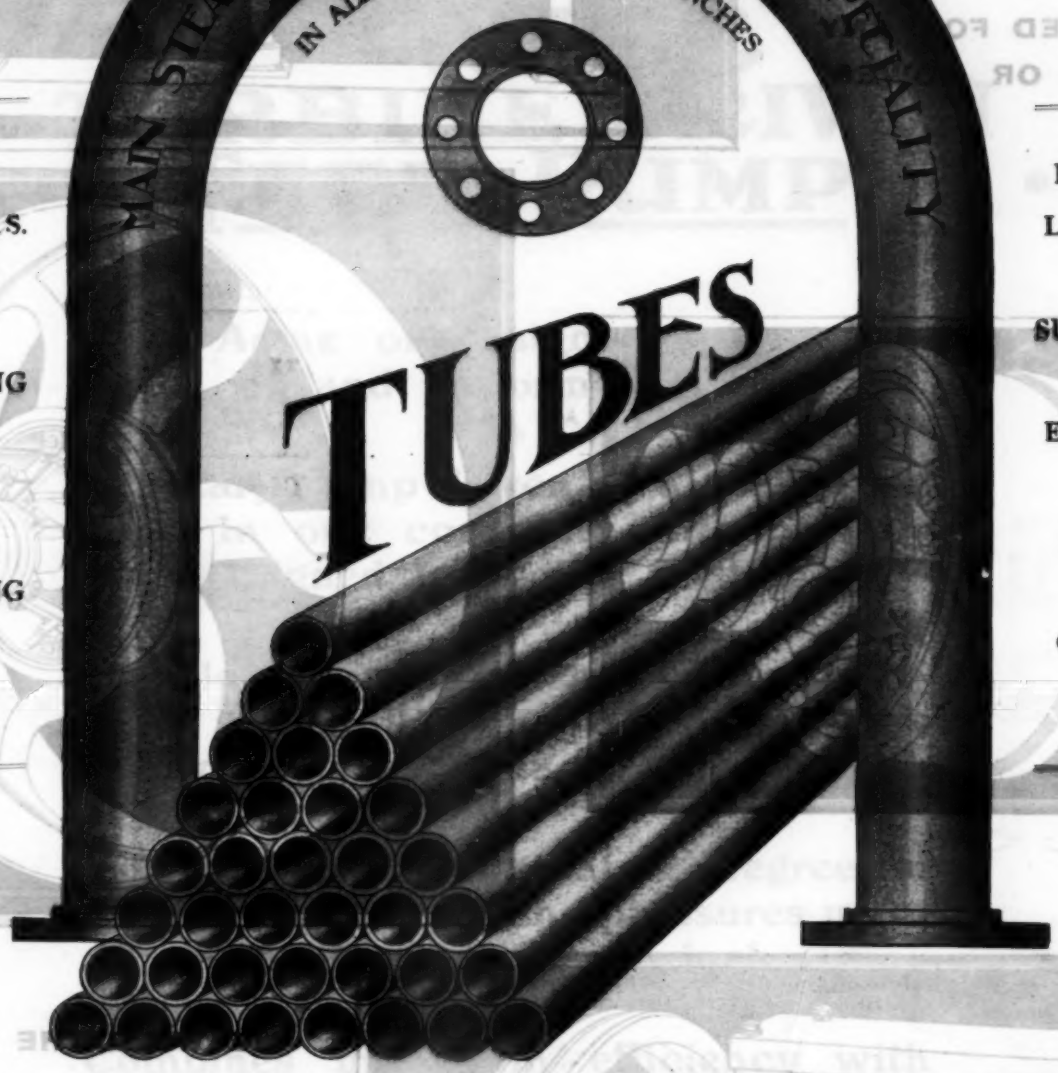
BRITISH MANNESMANN WELDLESS STEEL

IN LENGTHS UP TO 75 FEET WITHOUT CROSS WELD

MAIN STEAM PIPE INSTALLATIONS A SPECIALITY

IN ALL DIAMETERS UP TO 14 INCHES

BOILER STOOLS. FORGINGS FOR SHIPBUILDING COLLIERY AND GENERAL ENGINEERING PURPOSES, &c. &c.



TUBES

HYDRAULIC LOCOMOTIVE BOILER SUPERHEATER AND ECONOMISER TUBES, FLANGES, COILS, CYLINDERS, &c. &c.

ALSO MANUFACTURERS OF

LAP-WELDED TUBES

FROM 14in. UP TO 72in. DIAMETER FOR ALL PURPOSES.

LENGTHS UP TO 25 FEET.

THE BRITISH MANNESMANN TUBE CO. LD.

SALISBURY HOUSE, LONDON, E.C. 2.

Works: LANDORE, S. WALES, & NEWPORT, MON.

Branch Offices: BIRMINGHAM, MANCHESTER, GLASGOW, & NEWCASTLE.

DESIGN No. 17

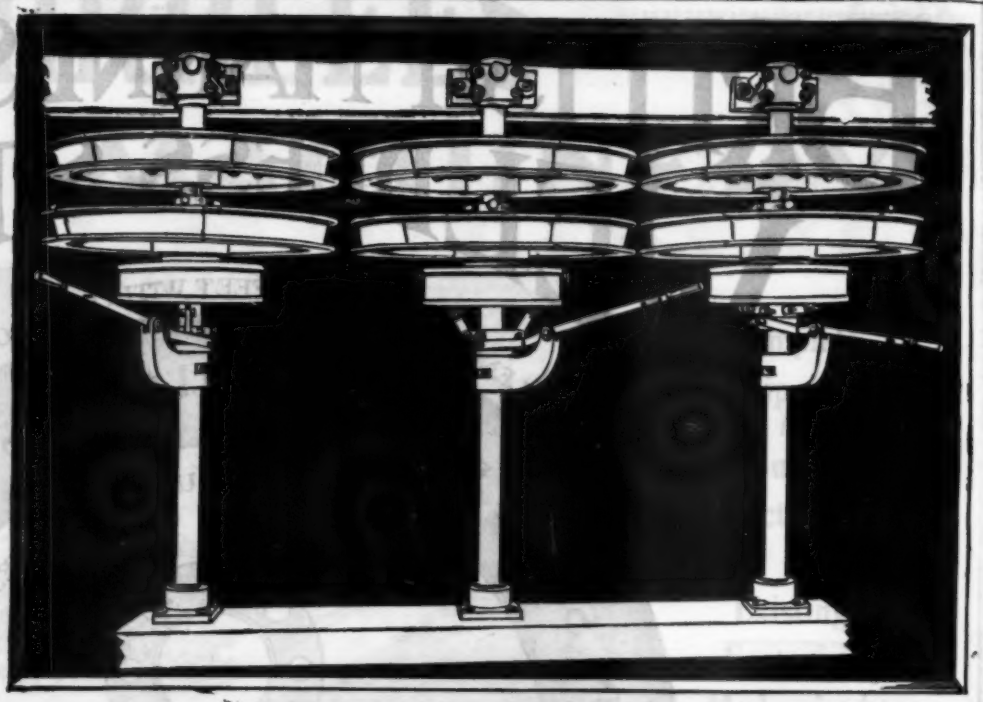
HARPER'S (COPYRIGHT) LIMITED.

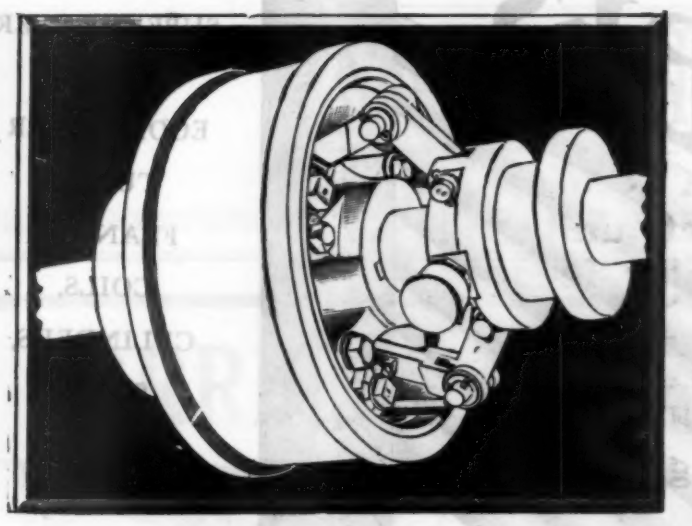
THE "MOWAT" PAT.
FRICTION CLUTCH.

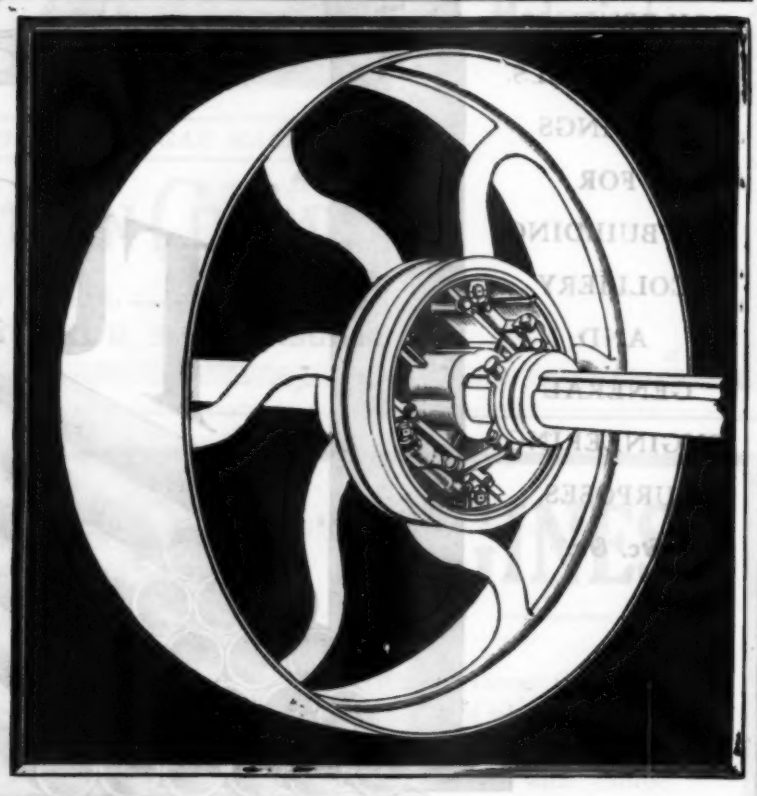
GRIP POSITIVE AND EQUAL AT ALL POINTS OF TREAD.

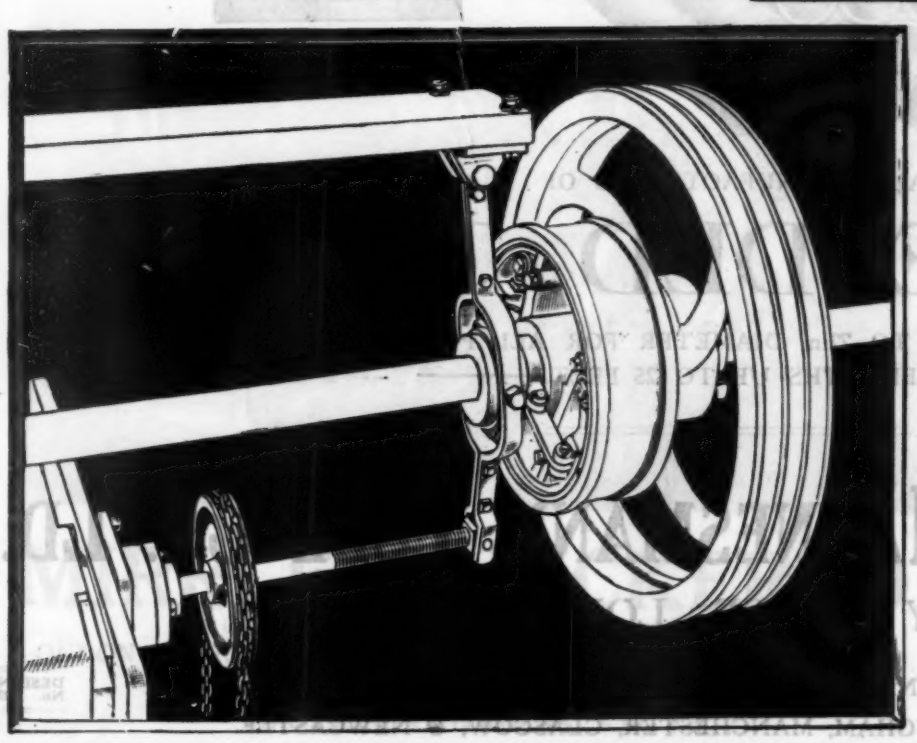
EXTREMELY SIMPLE AND ABSOLUTELY EFFECTIVE.

SUPPLIED FOR ANY SPEED OR POWER.





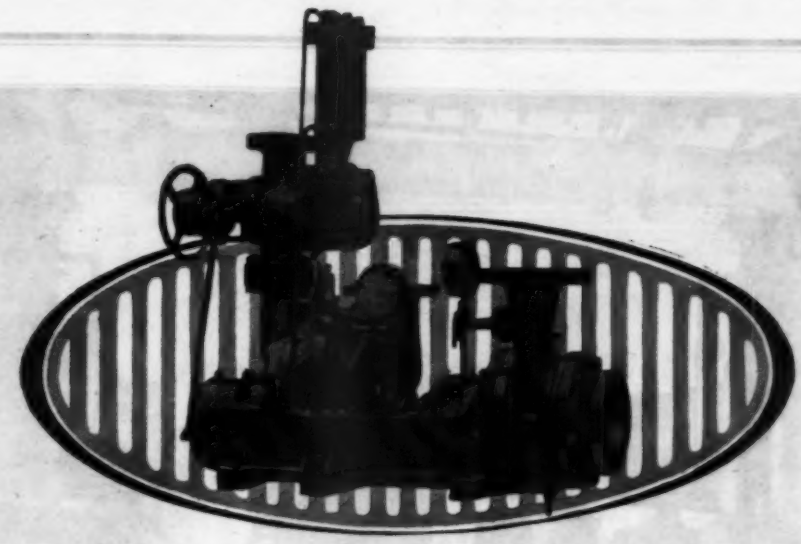




WE WERE THE FIRST TO SPECIALISE SOLELY IN THE MANUFACTURE OF ACCESSORIES FOR THE TRANSMISSION OF POWER.

HARPERS LIMITED, ABERDEEN.

Specialists in the Manufacture of Belt Pulleys, Rope Pulleys, Fly Wheels, Gear Wheels, Shafting, Pedestals and Fittings.



THE WEIR TURBINE DRIVEN FEED PUMP

The Acme of design, workmanship and performance.

✺

A rotary pump driven by a steam turbine in one compact unit specially designed for boiler feeding.

✺

Simple in arrangement; self-regulating; no shaft couplings; only two bearings; single stage pump wheel.

✺

Suitable for the greatest degree of superheated steam and pressures up to 600 lbs. per square inch.

✺

Combines maximum efficiency with minimum weight and space occupied.

✺

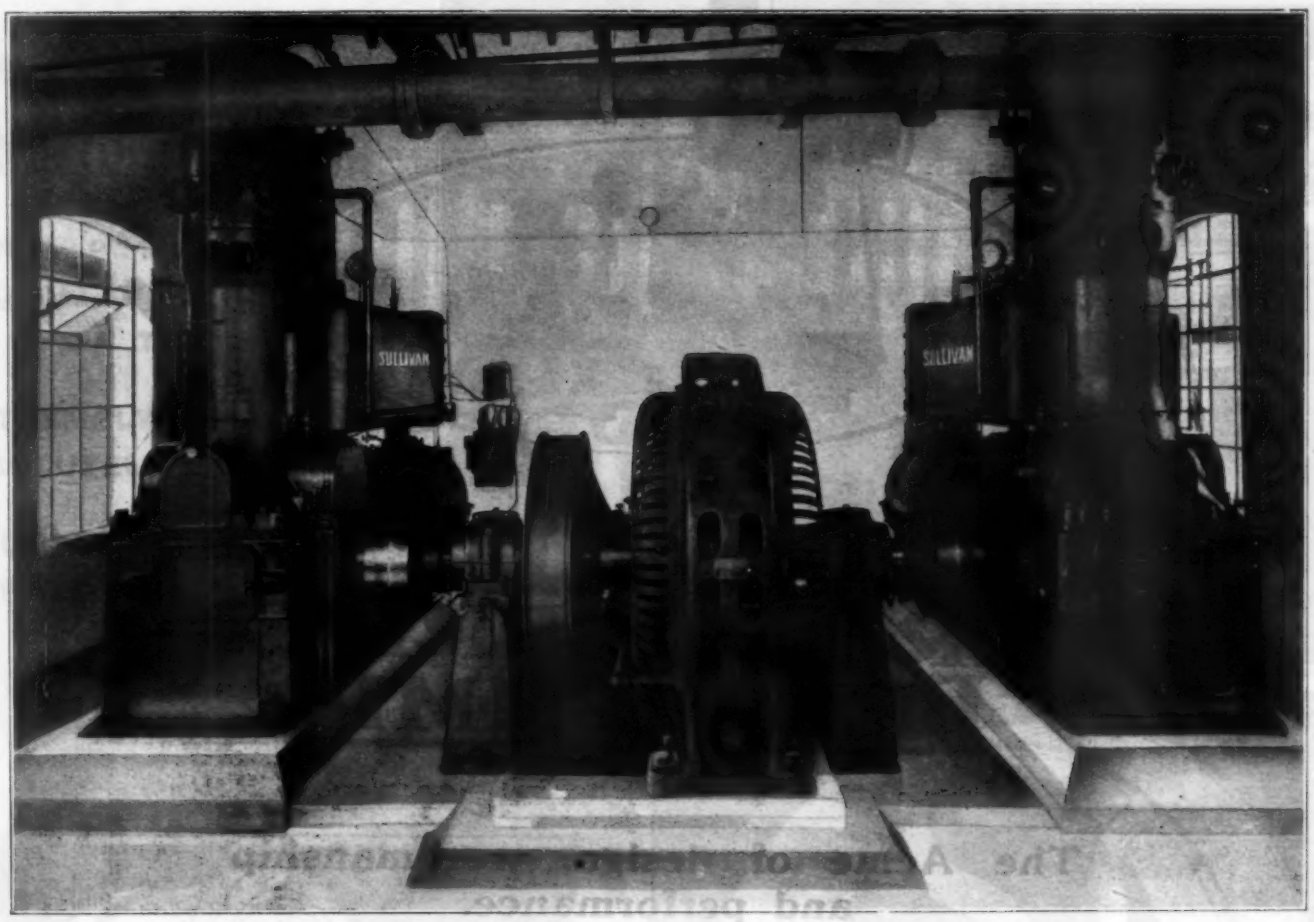
Low maintenance; hundreds in use giving the greatest satisfaction, delivering 7,000 to 50,000 gals. per hour.

✺

The last word in Power Station Auxiliary Equipment.

G. & J. WEIR LTD. CATHCART, GLASGOW.

E



DIRECT CONNECTED

Sullivan ANGLE COMPOUND Air-Compressors

DRIVEN BY

SELF-STARTING SYNCHRONOUS MOTOR

with Unity Power Factor.

Sullivan Angle-compound Air-Compressors, driven by Self-starting Synchronous Motors, represent the height of efficiency in compressing air, because

1. The arrangement of the cylinders at a right angle to each other means balance of reciprocating forces, with consequent long life due to the almost complete freedom from vibration.
2. The self-starting synchronous motor drive of unity power factor means that more favourable rates for power should be secured.

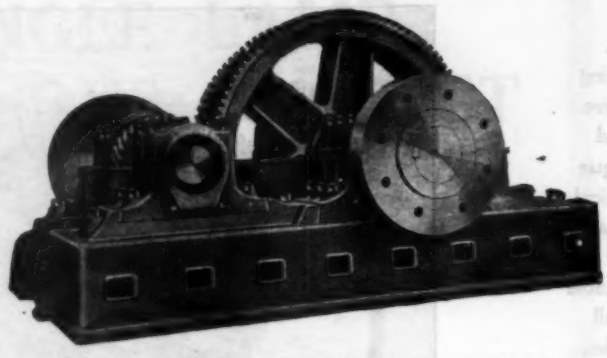
These machines are built in sizes from 900 to 3500 cu. ft. per minute. Send for catalogue 2577-B giving full details of these remarkable machines.

SULLIVAN MACHINERY COMPANY,

(Established 1850).

SALISBURY HOUSE, LONDON, E.C. 2.

Science & Accuracy in Gear Production



THE completely successful application of a correct principle can only be achieved in the case of high-speed gearing by the employment of the most scientific and accurate machinery and the exercise of the most meticulous care. It is to these matters that we have paid the greatest possible attention, with the result that double helical gears produced in our works can be guaranteed to run with perfect smoothness and a complete absence of shock or vibration and with the highest speed reduction ratios.

The characteristic freedom from shock and vibration of our Double Helical Gears enables the designer of power transmission systems to eliminate from his calculations the enormous margins that have to be allowed in the case of less accurately cut gears. As a consequence of this accuracy, relatively fine pitches can be employed, allowing the maximum number of teeth to be in simultaneous engagement. This is an important point, because it permits a uniform distribution of the load over the greatest possible tooth surface, and reduces wear and tear to a minimum.

Double helical gears for all purposes are made in our factory at West Drayton. These include gears for collieries, mines, steam turbine, oil and electrically-driven ships, power stations and industrial machinery of every kind.

The POWER PLANT CO., LTD.

WEST DRAYTON, MIDDLESEX, ENG.

To ENGINEERS IN ALL TRADES: FLEXSTEL Booklet, sent post free, records original practical money-saving facts.

Dorman's Patented Flexible Joints used with Hose is a guarantee against Hose breakages at acute working angles. FLEXSTEL Joints reduce Hose Renewals and maintenance costs

DORMAN'S

"FLEXSTEL"

DORMAN'S PATENTED EXPANSIBLE AND FLEXIBLE JOINTS in Steel and other Metals from ¼ inch to 12 inch bore. Guaranteed to withstand successfully the highest fluctuating and intermittent pressures for WATER, OIL, GAS, AIR, PETROL, ACIDS, SATURATED or SUPERHEATED STEAM and for many Trades and purposes. Joints are Standardized and Interchangeable. A line can be quickly and easily lengthened or shortened by unskilled labour without wasting any section.

A Striking Severe and Unique Practical Application.

Applicable to all Trades.

Adds life to Hose.

Flexstel Joints continue Absolutely Water Tight after withstanding for many months the strains of the open River Tides.

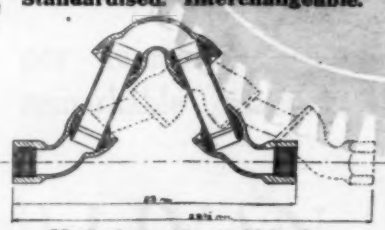
FLEXSTEL Patented Flexible Joints applied to 5 in. Corporation Water Main to FLOATING Landing Stage, Liverpool. Allows for 33 feet rise and fall of Tides.

UNIQUE FEATURES

FLEXIBILITY, SECURITY, NON-LEAKABLE, INDESTRUCTIBLE

End connection and joint of Standard Flexstel, proving flexibility at any pressures

A 2" pipe gives maximum movement up to 10° Standardised. Interchangeable.



Made from ¼ in. to 12 in. Bore.

Flexstel expansion joint, showing comparative movement.

NATIONAL PHYSICAL LABORATORY REPORT:

"Extensive and Severe destruction tests have been taken to prove the durability of Flexstel Patented Joints. A ½ inch bore Pipe-line was submitted to the National Physical Laboratory for destructive test. It ultimately gave out under a pressure of 9.2 tons per square inch, when the Pipe-line Metal fractured. The Flexstel joint being perfectly fluid proof till fracture occurred."

Dorman's Flexstel Patented Joints interposed with Plain Piping.

Flexstel Patented Joints constructed as pipe-lines of any length withstand any amount of rough usage, climatic conditions, high and intermittent pressures, and can be relied upon for conveying water, saturated or superheated steam, oil, compressed air or gasses, under any working pressures. The pitch of the Flexstel Joints regulates the flexibility and cost of the pipe-line. A pipe-line can be constructed of varying pitches, to meet special and actual conditions.

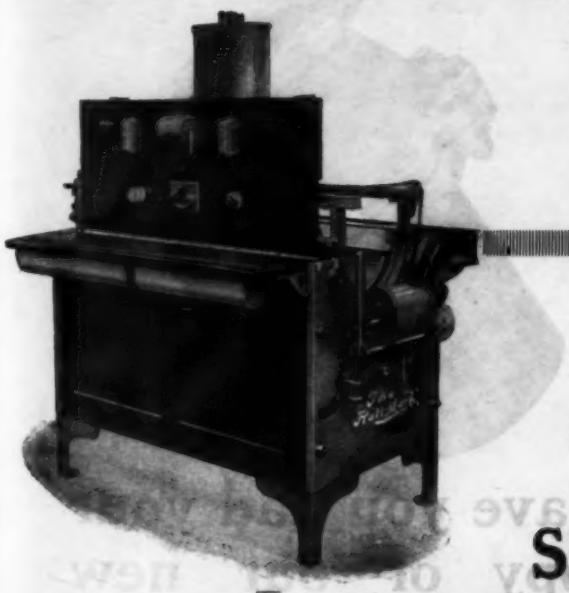
We illustrate an 8-foot length of ½ in. Flexstel line Dormans use regularly for water testing steel castings. No other flexible line will give anything like the life and reliability for purposes of this nature. A section damaged by the fall of a heavy casting can be replaced by unskilled labour.

An 8-ft. Flexstel Pipe Line complete with End Connections as illustrated £8

W. H. DORMAN & CO., Ltd., STAFFORD. Specialists in the Designing and Building of Petrol and Paraffin Internal Combustion Motor and Stationary Engines "The Heart of the Car is the Engine." Makers of Wave Transmission, Mining and other plants. Patent Owners and Makers of the Hele-Shaw Hydraulic (Oil) Clutch.

Head Office and Works: STAFFORD, ENGLAND.
Telephone N°.: 121 (3 lines).
Telegrams: "Dorman, Stafford."

London Office: St. Bride's House, Salisbury Sq., E.C.4
Telephone No.: 8127 Central.
Telegrams: "Typify, Fleet, London."



"The Hall-Mark"

SINGLE LAMP CONTINUOUS CONTACT PHOTO PRINTER

PATENT No. 170967.

Designed and Manufactured by the original inventors of the Electric Copier, constitutes the greatest advance yet made in apparatus for plan copying by electric light

B·J·HALL & Co., LTD.

CHALFONT HOUSE, GREAT PETER ST.,
WESTMINSTER : S.W.1.

Telegrams: "INSPECT, VIC. LONDON"
Telephone: VICTORIA 6693 (3 lines).

DEMONSTRATIONS BY APPOINTMENT.

PERFECT FOR BLUE PRINTS AND BLACK LINE WORK.

SWITCHGEAR

"THE PROOF OF THE PUDDING"—

F.P. Switchgear installations elicit many gratifying testimonials:

"We have used a very considerable number of your cubicles. The behaviour of your gear, at all times, has been exceedingly satisfactory, and the general finish and substantial character of the cubicle and its contents have given us complete satisfaction.

"We are convinced of the general superiority of your proposition."

—A Northern Corporation Electricity Dept.

"Very satisfied with the appearance and workmanship."

—An Eastern Counties Corporation Electricity Dept.

"Very pleased with the general appearance and standard of work."

—A Midland Corporation Electricity Dept.

Thirty H.T. remote control switches, after 10 years' service, during which many short circuits have been successfully dealt with, still stand up to the work satisfactorily, in spite of the load having trebled.

—Précis of a letter from a North-Western Corporation Electricity Dept.

"As good a job as I have yet seen."

A comment by a very well-known engineer on the sixth extension to a 40,000-volt F.P. installation in North Wales.

"Real top-hole stuff—about the best switchgear made."

—A prominent engineer's opinion of F.P. Switchgear.

"Very high-class quality. . . . . Do not recollect ever seeing a better turned out job."

—A large electric supply corporation in Australia.

FP Ferguson, Pailin Ltd

SWITCHGEAR SPECIALISTS

Head Office & Works,

HIGHER OPENSHAW, MANCHESTER

Telephone: Openshaw 329 • • • Telegrams "Tension" Manchester

Branch Offices:

LONDON - 37, Norfolk Street, Strand, W.C. 2.
BIRMINGHAM - - Daimler House, Paradise Street.
CARDIFF - - City Chambers, 47, Queen Street.
NEWCASTLE-ON-TYNE - 90, Pilgrim Street.
GLASGOW - - - - - 35, Robertson Street.
(Phone - Central 4214.)
BRANCH WORKS Marrickville, Sydney, Australia.

28 (E.P.S.)

Have you had your copy of our new valve list?

The Haste Foot Valve will appeal to every engineer on account of its great simplicity. The valve is the only working part—nothing to stick or cause trouble.

New lists giving dimensions, prices, etc., will be sent post free on application.

The PREMIER

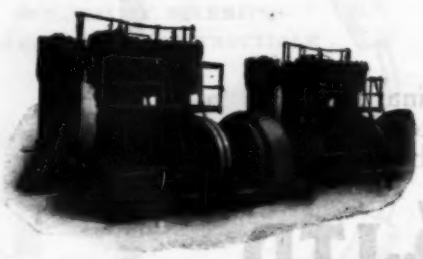
COOLER & ENGINEERING CO., LTD.,

Station Works, Shalford, Nr. Guildford, Surrey.

WALKER BROS. (WIGAN)

LIMITED.

Codes: A B C, 4th & 5th, Lieber's, Western Union, Morsing and Neal Mining.



Vertical Motor Driven Two-Stage Air Compressing Engines of the Quick Revolution Type.

AIR COMPRESSORS

with light Disc Valves to recent Patents now at work (*or on order*) indicating over

160,000 raising total output to **520,000 H.P.**

Patent Unloading Device and Output Regulator, for Power Driven Plants.

VENTILATING, WINDING AND GENERAL MINING MACHINERY

B

PAGEFIELD IRONWORKS, **WIGAN.**

Telegraphic Address: "Pagefield, Wigan." *Telephone:* No. 714 Wigan (3 lines).

HALDEN

DRAWING INSTRUMENTS AND DRAWING OFFICE EQUIPMENT

For Engineers, Contractors, Shipbuilders.

ANYTHING FROM A SMALL RULING PEN TO A COMPLETE UP-TO-DATE INSTALLATION OF FURNITURE, INCLUDING HIGH-SPEED BLUE PRINTING MACHINES AND SIMILAR PLANT.

J. HALDEN & CO., LTD.,

8, ALBERT SQUARE, MANCHESTER.

Depots:
LONDON, NEWCASTLE-ON-TYNE, BIRMINGHAM, GLASGOW & LEEDS.

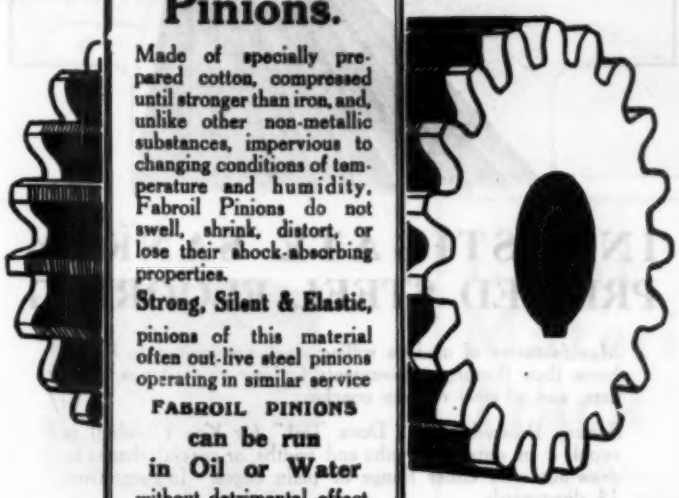
Foreign Agencies:

AUSTRALIA—A. Brydges-Todd, Aberdeen House, 528, Collins Street, Melbourne.
SOUTH AFRICA—The Griffin Engineering Co., Ltd., 94, Main Street, Johannesburg.
FRANCE—A. Deloffre, Palais de la Bourse, Lille.
ARGENTINE—E. F. Bideleux, Calle Chacabuco 443, Buenos Aires.

Stop that Noise! Use

Fabroil

Pinions.



Made of specially prepared cotton, compressed until stronger than iron, and, unlike other non-metallic substances, impervious to changing conditions of temperature and humidity, Fabroil Pinions do not swell, shrink, distort, or lose their shock-absorbing properties.

Strong, Silent & Elastic,

pinions of this material often out-live steel pinions operating in similar service

FABROIL PINIONS

can be run in Oil or Water

without detrimental effect.

The British Thomson-Houston Co., Ltd.,

Electrical Engineers and Manufacturers,

Head Office and Works . . Rugby, England.

WICO HIGH TENSION MAGNETOS

for all one cylinder engines

A New Magneto.

The Wico Magneto is a complete departure from all previous ignition devices. Wico simplicity has taken the place of the old-fashioned mysterious magneto.

Wico Magnetos will stand exposure and abuse which would ruin any other magneto.

For industrial, agricultural and marine internal explosion engines, Wico Magnetos are unequalled.

Let us supply complete details.

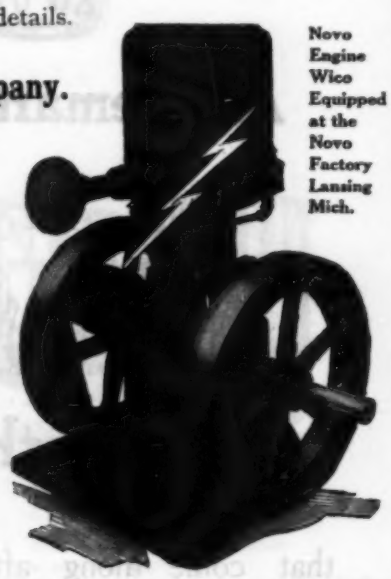
Wico Electric Company.

Works: Springfield, Mass., U.S.A.

Export Office:
39, Water Street, New York, U.S.A.

Cable Code: Wilbloco.

Codes: Bentleys, A.B.C. 5th Edition, Western Union.



Novo Engine Wico Equipped at the Novo Factory Lansing Mich.

PUMPS FOR ALL PRESSURES.

SEND YOUR ENQUIRIES.

Hydraulic Pumps.

NEW DESIGN.

THE photo shows a set of Standard Hydraulic Pumps, two-throw. The tight pulley is a heavy flywheel and the bearings are of gun-metal The shaft is of mild steel, and the bodies and valves are of hydraulic gun-metal. The stand and uprights are all cast in one piece.

LATEST DESIGN

Hand Hydraulic Pump.

THE photo shows a set of double plunger Hand Pumps, with a large plunger for getting up the press rams quickly, and a small plunger for putting on the final pressure. They are shown complete, standing on a tank.

HOLLINGS & GUEST, LTD.

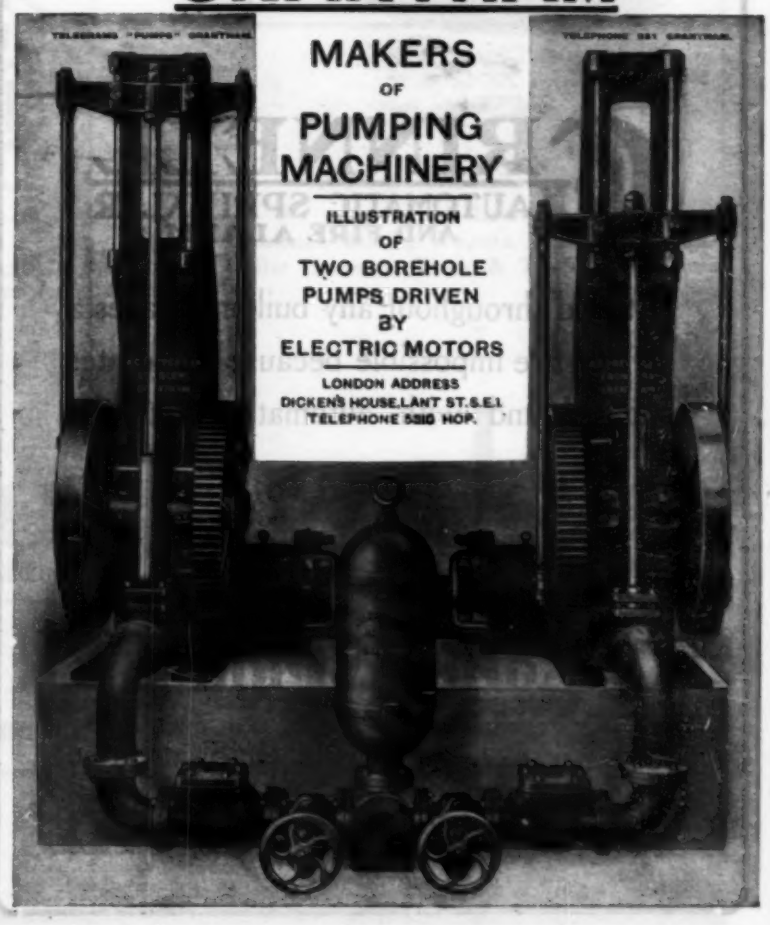
Thimble Mill Lane, Birmingham.

Sole Agent for Scotland:—
MR. D. LANDALE FREW, 45, Hope St., GLASGOW.

A.C.POTTER & Co

ENGINEERS

GRANTHAM



A fireman in time-

-is better than nine

that come along after the fire has got a hold. The Grinnell Automatic Sprinkler is the "Fireman" that is always in time because it is always **on the spot** before the fire breaks out.

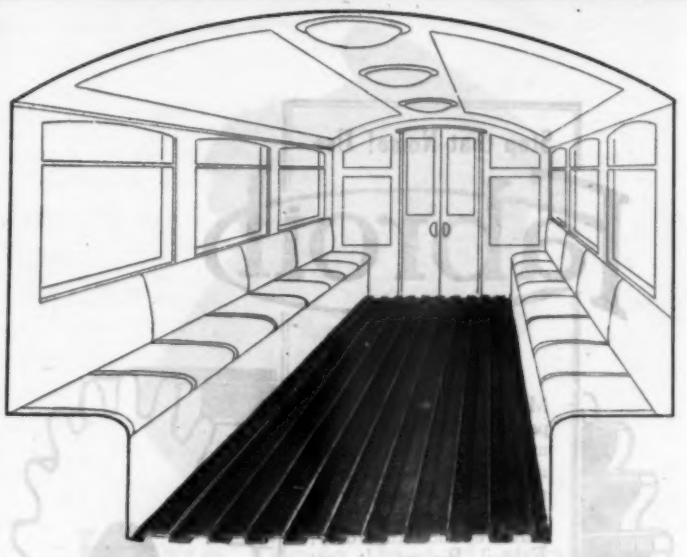
GRINNELL
AUTOMATIC SPRINKLER AND FIRE ALARM

installed throughout any building makes a serious fire impossible because it operates unaided and with automatic certainty.

Mather & Platt, Ltd.

Park Works, MANCHESTER.

14, Gt. Smith Street, LONDON, S.W.



INVESTIGATE SANKEY PRESSED STEEL FLOORING

Manufacturers of modern rolling stock are invited to let us know their flooring requirements for motor omnibuses, tram cars, and all-steel railway coaches.

Sankey Pressed Steel "Dove Tail" (or Key Flooring) is supplied in suitable lengths and widths, or special shapes to drawings, with either flange or plain edges. In gauge from 14 downwards.

Width and depth of "Dove Tail" can be varied as desired.

The success of Sankey Pressed Steel Flooring has been immediate, and it is recognised by leading authorities as a flooring of sound construction and great durability.

JOSEPH SANKEY & SONS, LTD.
HADLEY CASTLE WORKS, WELLINGTON, SHROPSHIRE
Telegrams: "Sankey, Wellington, Shropshire." Telephone: Wellington, Shropshire 66.

Telegrams— "BRAKE," Manchester. "EXCLUDING," Via. London.
Telephone— No. 613 CENTRAL, Manchester. Nos. 9770—9771 VICTORIA, London.
CABLE ADDRESS: "BRAKE" MANCHESTER. CODES: A.B.C.

GRESHAM'S PATENT

INJECTORS

Hot Water Injectors for dealing with water up to 140 deg. with 180 lb. pressure.

Largest and Oldest Makers of Injectors in the Kingdom.
Every Class of Injector Made.

GRESHAM & CRAVEN LTD.,

HEAD OFFICE AND WORKS:
ORDSALL LANE, SALFORD, MANCHESTER.

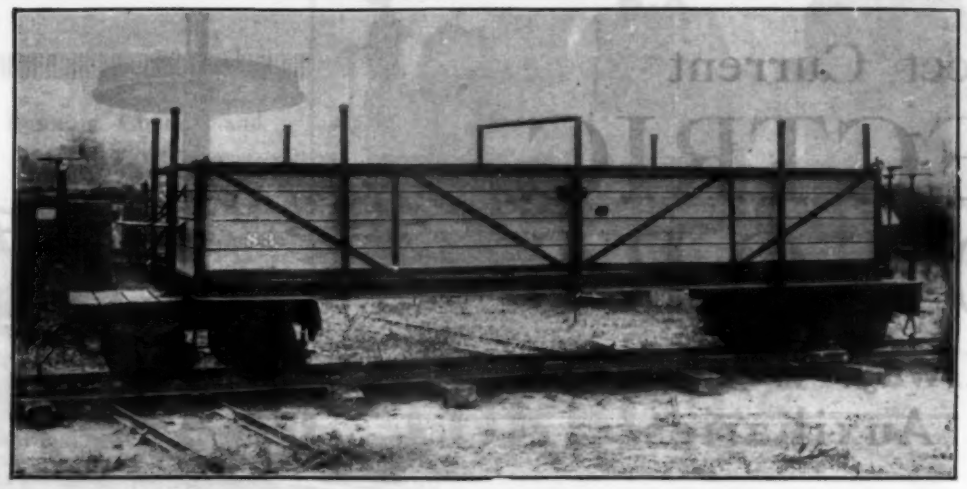
London Office:
40, WOOD STREET, WESTMINSTER, S.W. 1.

GLASGOW OFFICE: WM. LESTER & SONS, 11, WEST REGENT STREET.
NEWCASTLE-ON-TYNE OFFICE: FRED CRIPWELL, 18, BIGG MARKET.
BELFAST OFFICE: R. PATTERSON & SONS, 13 & 15, BRIDGE STREET

OVERSEAS AGENTS:

FRANCE, BELGIUM, SPAIN AND PORTUGAL: Walter Strapp, 15, Rue de Madrid, Paris.
HOLLAND: Th. H. M. De Grijs, 311, Rijswijkschweg, The Hague.
ITALY: Giovanni Checchetti, Piazza Sicilia, 1, Milan.
AUSTRALIA: Adams & Co., 521-523, Collins Street, Melbourne.
INDIA: Heatly & Gresham Ltd., 204, Hornby Road, Bombay. Madras: 8, Popham's Broadway.
Do. 6, Waterloo Street, Calcutta. Lahore. 8, Egerton Road.
SOUTH AMERICA: Evans, Thornton & Co., 465, Calle Defensa, Buenos Ayres.
POLAND, ROUMANIA AND THE NEW STATES: British Engineers & Traders Syndicate Ltd., Australia House, Strand, London, W.C.
SOUTH AFRICA: Jenkins & Co., 13-14, Greenmarket Square, Cape Town.
Do. 362, Smith Street, Durban.
Do. Ginsberg Chambers, Johannesburg.

EVERYTHING FROM TRACK TO LOCOMOTIVES.



E 1016. DOUBLE BOGIE BOX WAGONS with movable wood sides and ends. Inside dimensions 15' 8" x 5' 6" x 2' 3½"

E 456. SIDE DISCHARGE WAGONS with gable bottom. We always stock many other types.

Light Railway Material—from Track to Loco.

Specify Hudson Material for your Light Railway—its efficiency will give complete satisfaction, keep your maintenance costs at a low level and considerably increase the life of your installation.

Over fifty years' experience has taught us how to design material that is best adapted for Light Railway work; our designers are experts with wide and practical knowledge—our workmen specially skilled—our methods of construction are the best in engineering practice.

Before placing any contracts we invite you to investigate the merits of the Hudson Material.

Write for our catalogue—
"Light Railway Material."

We have always a stock on hand of about 40,000 tons, all sizes, types and capacities.

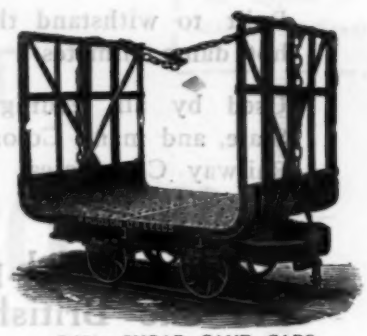
HUDSON RAILWAY MATERIAL

Phone: 20004

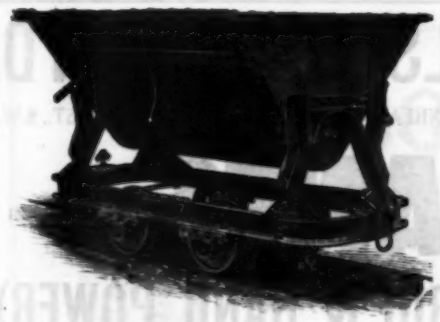
Codes: ABC, 5th & 6th, Bentley and Marconi.

Telegrams: "Raletrux, Leeds."

CATALOGUES IN ENGLISH, FRENCH, SPANISH & PORTUGUESE.



E 831. SUGAR CANE CARS. Every type used by different countries in various gauges



E 769. SIDE TIPPING WAGONS in all sizes, from half-ton to 10 tons capacity.

E 750. BALL BEARING TURNTABLES, in numerous sizes, types, and gauges.

We also supply Locomotives, Switches, Crossings, Mining Wagons, Wheels & Axles, Roller Bearings, Track & Track Accessories.

Robert Hudson Ltd.

Head Office:- 38A BOND ST. LEEDS Works:- GILDERSOME FOUNDRY.

LONDON OFFICE: Suffolk House, Cannon Street, E.C.4. Telephone: 3162 City.

FRANCE: Robert Hudson Ltd., Camp Français, Beauvainville P. de C.

INDIA: Robert Hudson (India), Ltd., P.O. Box 23, Calcutta. P.O. Box 370, Bombay. Works: Kidderpore.

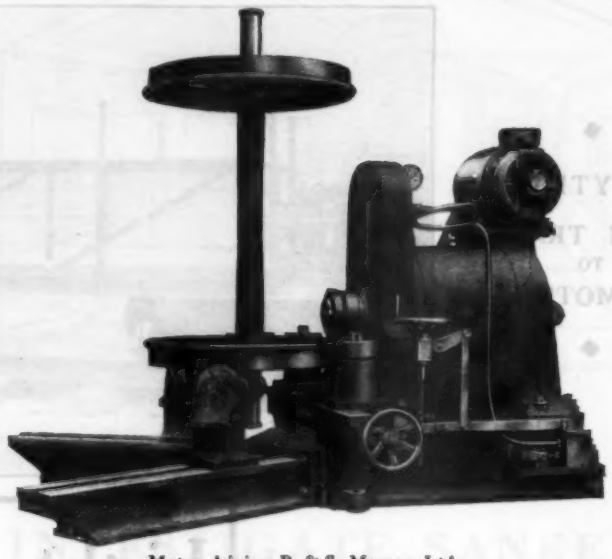
AFRICA: Robert Hudson & Sons, Ltd., P.O. Box 5744, Johannesburg. Also at Durban, Lourenco Marques, Beira, Loanda, Mauritius, etc.

EGYPT: Robert Hudson, Ltd., P.O. Box 1446 Cairo. Also at Alexandria.

Direct Current

ELECTRIC MOTORS

for Railway Workshops and Auxiliaries.



Motor driving B. & S. Massey, Ltd., Tyre Fixing Rolls.

Robust in construction, reliable in operation, competitive in price, and available at short notice.

Built to withstand the difficulties of hot damp climates.

Used by all leading British, Indian State, and many Colonial and Foreign Railway Companies.

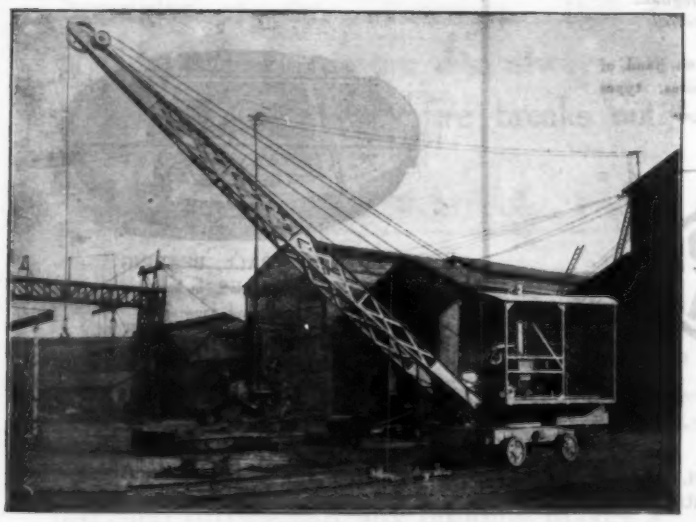
Over 1,500 h.p. supplied to one British Railway Company.

"Magnet," Manchester. 741 Openshaw.
"Orders," Cannon, London. 5370 City.

Electromotors Limited

OPENSHAW:

London 49 Queen Victoria St. E.C.



TWO-MOTOR ELECTRIC LOCOMOTIVE CRANE.

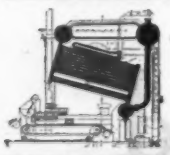
JOHN H. WILSON & CO. LTD.

Head Office & Works: Dock Rd., BIRKENHEAD. London Office: 15, VICTORIA ST., S.W.1.

CRANES

(STEAM, ELECTRIC & HAND POWER).

CRANE-NAVVIES, WINDLASSES, WINCHES, EXCAVATORS, DECK MACHINERY.



SPEARING WATER-TUBE BOILERS.

TUBE RENEWALS ELIMINATED
by positive and adequate supply of water to the bottom tubes.

SCALE ELIMINATED
by providing for the settlement of sediment in LARGE MUD DRUMS.

SOLID DRAWN HEADERS.

CONTRACTS FOR SIX SUPER POWER STATIONS
now in progress, including BOILERS OF 75,000 lb. EVAPORATION PER HOUR EACH.

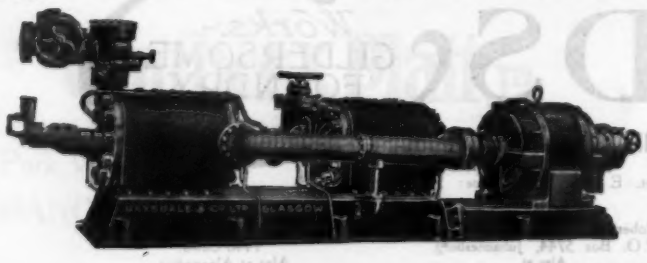
SPEARING BOILER CO., LTD., 20, Kingsway, London, W.C. 2.

FERGUSON SUPERHEATERS.

Sections easily replaced.
Sections interchangeable.
Joints outside path of gases.
Headers and Tubes of Solid Drawn Steel.

Ferguson Superheaters,
20, Kingsway, London, W.C. 2.

Fig. 285



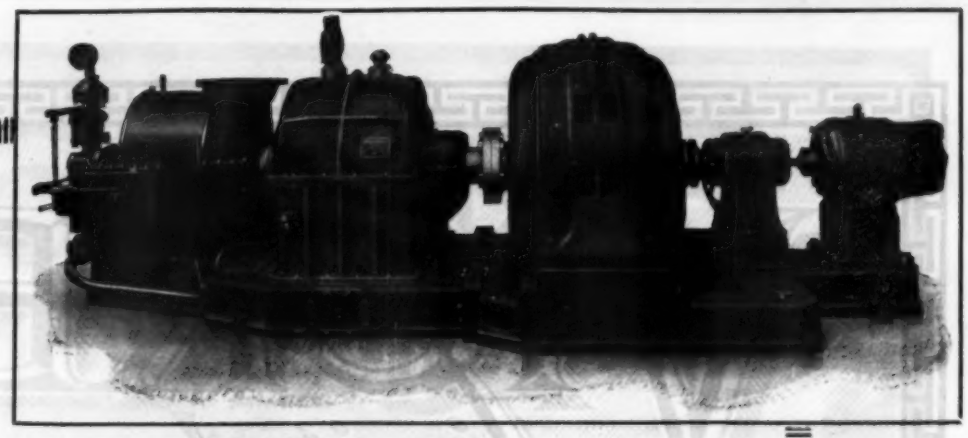
Electrically Driven Turbine Pump for High Pressure Hydraulic Service, 750 lb. per square inch.

TURBINE PUMPS

FOR OPERATING

HYDRAULIC CRANES, CAPSTANS, &c.

DRYSDALE & CO., Ltd., Yoker, GLASGOW, W.



MINIMUM Running Charges and Attendance.

MAXIMUM Economy, Reliability and Simplicity.

Complete Installations Alternating or Direct Current. Direct or Gear Drive.

STEAM TURBINES

AND

High Pressure
Mixed Pressure

GENERATORS

Low Pressure
Pass-Out

Illustration shews 600 K.V.A. Geared Set supplied to Colliery in Midlands

All types of:—

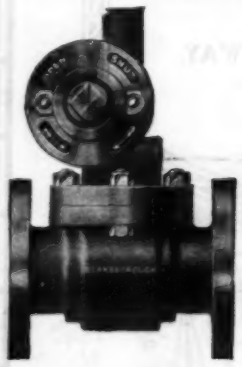
CONDENSING PLANT.

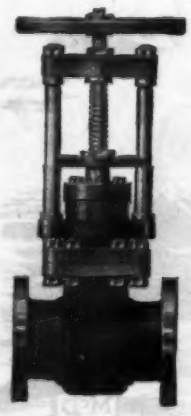
W. H. ALLEN, SONS & CO. LTD.

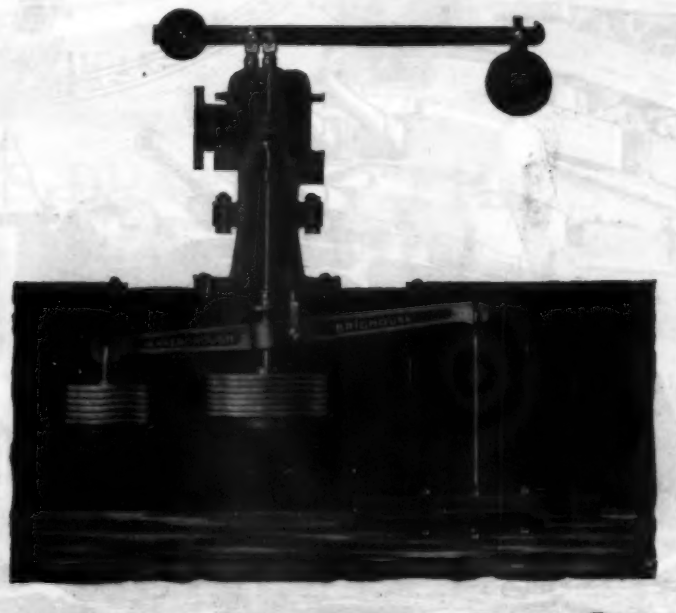
BEDFORD, ENGLAND.

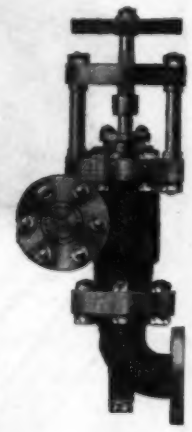
BOILER MOUNTINGS

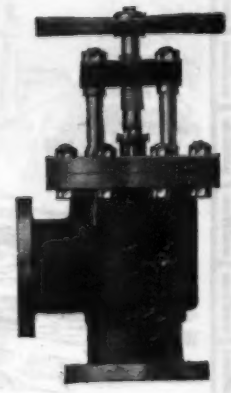
AND VALVES.











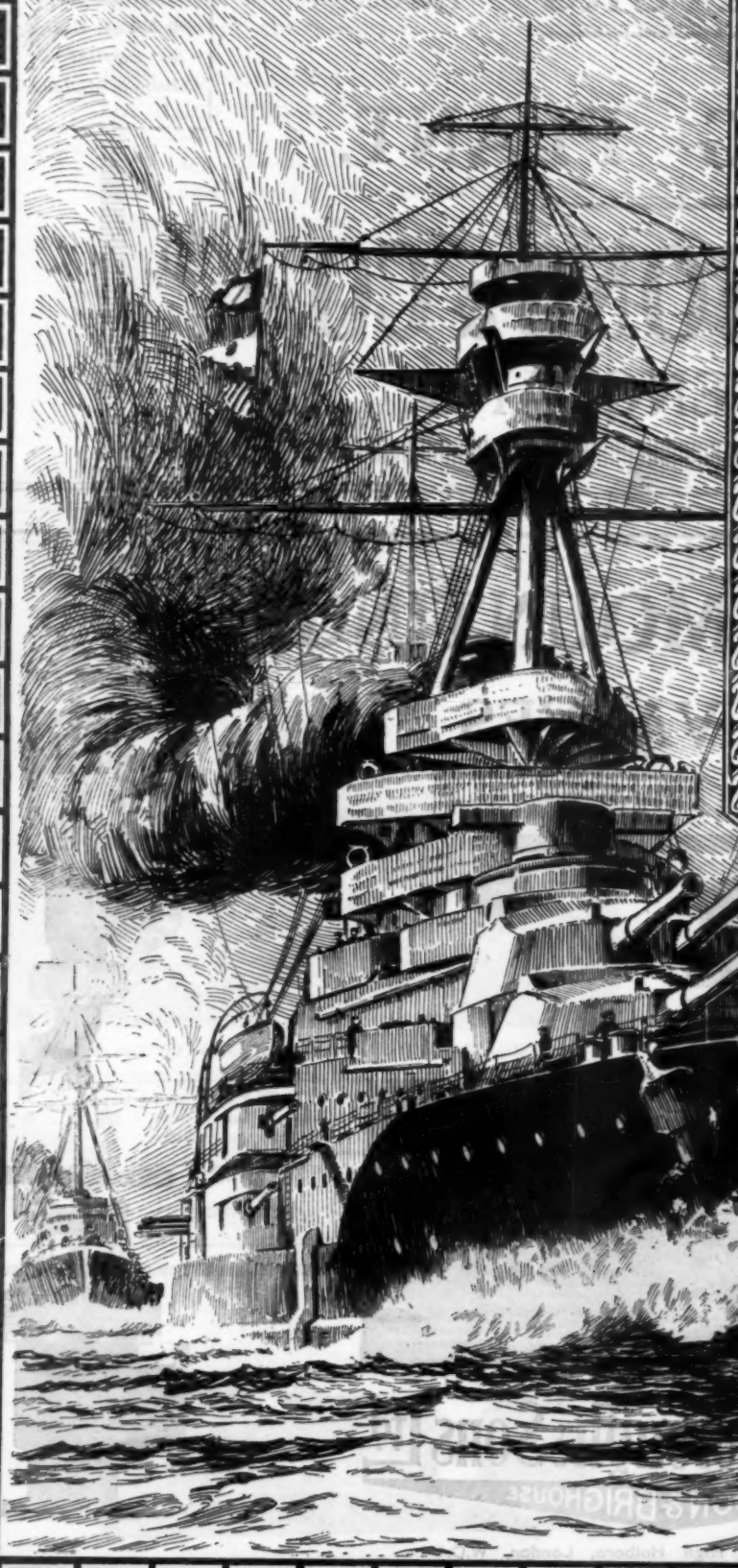
J. Blakeborough & Sons Ltd

LONDON & BRIGHOUSE

Sales Office: 199, High Holborn, London, W.C.1.

G

VICKERS Limited



WARSHIPS.

Commercial Ships. Mail and Passenger Steamers. Marine Engines of all descriptions, including Turbine and Heavy Oil Engines. Large Gas Engines. Floating Docks and Cranes. Icebreakers, Dredgers and other Special Craft. Michell Thrust Bearings for all purposes. Contraflo Specialities for Ships' Auxiliary Machinery. Guns and their Mountings. Armour Plates. Rubber Making Machinery. Mining, Cement Making, and Stone Crushing Machinery. Oil Well Supplies and Equipment. Hydro-Electric Power Installations. Drifting Sand Filters for Water Purification. Cardbox Making Machinery. Machines for the manufacture of Concrete Bricks, Tiles and Slabs. Engineers' Small Tools. Machine Tools. Target and Sporting Rifles. "Vickers' Duralumin" (Registered Trade Mark). Train Lighting Equipment. Waterproof Plywood. Porcelains for all Electrical Purposes. Gas Meters. Etc. Etc.

Branch Offices: MANCHESTER, BIRMINGHAM, NEWCASTLE-ON-TYNE, BRISTOL, LEEDS, BELFAST.

Depots: GLASGOW, DUBLIN.

Works: BARROW-IN-FURNESS, SHEFFIELD, ERITH, BIRMINGHAM, CRAYFORD, DARTFORD, WEYBRIDGE.

Head Office:

VICKERS HOUSE, BROADWAY, LONDON, S.W. 1.

McD

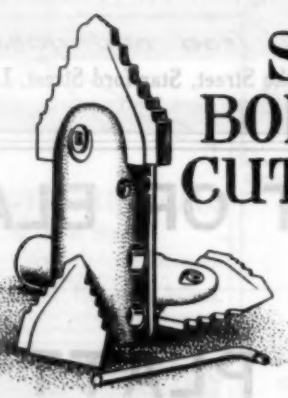
VICKERS LIMITED

SPRINGS

OF EVERY DESCRIPTION

SPIRAL AND STRAIGHT TOOTHED BEVEL GEAR WHEELS

WELDLESS DRAWN STEEL TUBES



S.R. BORING CUTTERS

DROP FORGINGS AND STAMPINGS.

Locomotive Crank Axles. Straight Axles for Locomotives, Carriages and Wagons. High Tensile Steel Tyres ("Australia Brand"). Vanadium High Speed and other High Grade Tool Steels. Alloy Steels of all kinds suitable for Engine and Constructive Work. Rustless Steel in Bar, Tube, or Sheet. Sheets in High Tensile Carbon and Alloy Steels. Gauge Plates. Cast Cutters. Motor Car Pressings. Magnets. Jigs. Gauges. Fixtures. Special Tools. Surface Hardening by Patented Process. Etc. Etc.

Head Offices:
VICKERS HOUSE, BROADWAY, LONDON, S.W. 1.

Depots:

DUBLIN: 32, Nassau Street. | GLASGOW: Vickers House, 247, West George Street.

Branch Offices:

MANCHESTER: Millgate Buildings, Long Millgate.
LEEDS: Greek Street Chambers, Park Row.
BIRMINGHAM: Vickers House, Loveday Street.
BRISTOL: 55, Park Street.
BELFAST: 26a, Arthur Street.
NEWCASTLE-ON-TYNE: Commercial Union Buildings, Pilgrim Street.

River Don Works, SHEFFIELD.

FILES OF EVERY DESCRIPTION AND HACK SAW BLADES

REGISTERED TRADE MARK

Manufacturers of

TRADE HECLA MARK

STEEL FORGINGS

in the rough, rough machined, or finished. For Marine and other Engineering purposes of any analysis and to pass any required test.

INGOTS, BLOOMS, SLABS,
made by the
OPEN HEARTH OR ELECTRIC PROCESS.

STEEL CASTINGS

of every description up to 30 tons in weight.

Makers of the latest types of
STONE BREAKING and ORE CRUSHING MACHINERY.

Sole Makers of Hadfield's Patent

ERA TRADE MARK **Manganese Steel**

The Supreme Material for Railway and Tramway Special Track work; also wearing parts of Stone Breaking, Ore Crushing, and other Machinery.

COMPLETE TRAMWAY LAY-OUTS WITH POINTS AND CROSSINGS.

TRADE HECLON SUPERIOR MARK

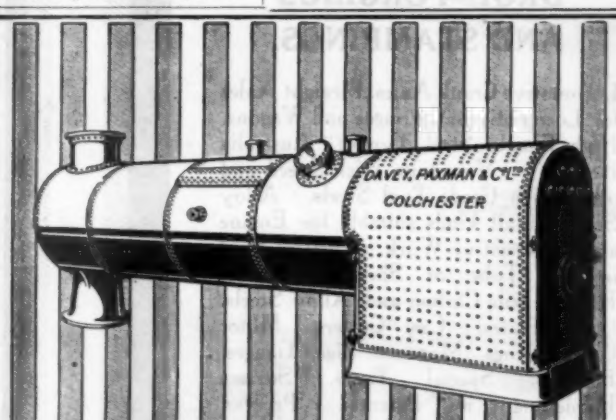
High Speed Tool Steel
The finest air hardening steel for machining the hardest and toughest material.

Works Area over 200 Acres. Buildings cover 61 Acres.

Workmen employed during the War 15,000.

HADFIELDS Ltd.

East Heela and Heela Works,
SHEFFIELD, England.
London Office: Norfolk House, Laurence Pountney Hill, E.C. 4.



Paxman

Locomotive Boilers are made in all sizes from 2 H.P. upwards, and suitable for working pressures of 120 lb. and upwards. Easily installed, no foundations and no brickwork setting being required, neither brick chimney. This type of boiler contains a large heating surface and grate area in a comparatively small space. Can be arranged to burn any kind of fuel. Steam can be raised in less than a quarter of the time required by non-tubular boilers.

Let us send you further particulars.

DAVEY, PAXMAN & Co., Ltd.
(Branch of Agricultural & General Engineers Ltd.),
COLCHESTER, and Central House, Kingsway, London, W.C. 2.

To Machinery Buyers Abroad

Registered

Cables: "Endeavour, London."

Have your own Buying Agents in London.

MANY firms abroad find it convenient to have a London Agent for the purchase, inspection and shipment of all their supplies. We have been established over 40 years and conduct a business which takes effect in every quarter of the globe and embraces large transactions in metal, machinery of all kinds, machine tools, engines of every type, steamboats, motor boats, motor cars, railway material; everything, in fact, which comes within the province of modern engineering production. We invite firms and Buyers abroad to appoint us their London Agents and desire correspondence with regard to terms, finance, shipping, etc.

JOHN BIRCH & CO LTD

EXPORT ENGINEERS, &c &c.
2, LONDON WALL BUILDINGS, LONDON, E.C. 2.

DIXON'S PIPE JOINT COMPOUND

USED BY ENGINEERS EVERYWHERE FOR OVER FIFTY YEARS.

~makes a tighter joint than red lead and goes further:~

C.R. AVERILL (SOLE AGENT) JOSEPH DIXON CRUCIBLE Co - 22, Duke Street, Stamford Street, London, S.E. 1.

STUDS.

BRIGHT OR BLACK.

ISAIAH PLATT LD.,

BRITISH EMPIRE WORKS,
WEDNESBURY.

Printing.—George Reveirs, Ltd., 4/5, Greystoke-place, Fetter-lane, E.C. are PREPARED to SUBMIT ESTIMATES for all DESCRIPTIONS of PRINTING. "THE ENGINEER" has been printed at this Establishment since its commencement.

PATENTS, DESIGNS and TRADE MARKS in all countries.
E. P. ALEXANDER AND SON,
Chartered Patent Agents,
6&8, HIGH HOLBORN, LONDON, W.C. (Estab. 1870).
Telephone, Central 7424. 1L

PATENTS, DESIGNS, AND TRADE MARKS.
Harris & Mills, Chartered Patent AGENTS, 34 and 35, High Holborn, London.
Established 1869.
Tel. Ad. "Privilege, London." Tel. No., Chancery 7765

PATENTS, TRADE MARKS & DESIGNS IN ALL COUNTRIES.
LEWIS WM. GOOLD
CHARTERED PATENT AGENTS,
British Members of the American Patent Law Association and of the Institute of Patent Attorneys of Australia.
INCORPORATING:
LEWIS WM. GOOLD, A.C.I.P.A., C.I.MECH.E. ROWLAND L. GOOLD, F.C.I.P.A., F.C.S., A.I.A.E., A.I.E.E.
Telegrams: "Diplomacy," Birm. *Telephone: Central 3700*
6 CORPORATION STREET, BIRMINGHAM.

BULL'S METAL & MELLOID CO.,
Yoker, nr. Glasgow. LTD.
Tel.: Melloid, Yoker. Telephones: 182, 183 Clydebank.
BULL'S METAL.—Propellers, Bars, Sheets, Pump Rods, Valve Spindles, Condenser Stays and Plates, &c.
MELLOID (Reg. Trade Mark).—Condenser and Boiler Tubes, Stays and Plates, Bars, Sheets, Valves, &c.
HIGH TENSILE BRONZE.—Cast, Rolled, Forged, to Admiralty Requirements.
WHITE METALS.—Tempalto, Babbits, Plastic, &c.

THE GLASGOW RAILWAY ENGINEERING COMPANY LTD.
GOVAN, GLASGOW.
London Office:—12, VICTORIA STREET, S.W.
MANUFACTURERS OF RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES, CARRIAGE AND WAGON IRONWORK, also CAST STEEL AXLE BOXES.

ESTABLISHED 1861.
HARRISON & CAMM, Ld.
Chief Works and Offices: ROTHERHAM.
Manufacturers of
WHEELS & AXLES
with Cast or Hydraulic Forged Naves or Cast or Rolled Steel Disc Centres.
Wagon Ironwork, Iron and Brass Castings for Wagons, and other Repetition Work.
RAILWAY WAGONS (in Iron, Steel, or Timber).

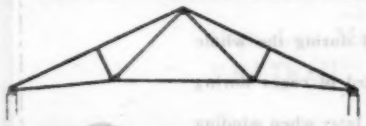
GLASGOW ROLLING STOCK & PLANT WORKS.
HURST, NELSON & CO., LTD.,
Builders of RAILWAY CARRIAGES, WAGONS, ELECTRIC CARS, and every other description of RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS, AXLES, RAILWAY PLANT, FORGINGS, SKATE WORK, and IRON and BRASS CASTINGS.
Registered Office and Chief Works: MOTHERWELL.
Cardiff Office: Gordon Chambers, 31, Queen Street.
London Office: 14, Leadenhall Street, E.C.
See Illustrated Advt. last week, page 41.

P. & W. MACLELLAN, LTD.
CLUTHA WORKS, GLASGOW,
Manufacturers of RAILWAY WAGONS and CARRIAGES, IRON and STEEL SLEEPERS, FISH-BOLTS, SPIKES, and other PERMANENT WAY MATERIAL, BRIDGES, and ROOFING.
CONTRACTORS for RAILWAY PLANT and STORES of every description.
Chief Offices: 120, Trongate, GLASGOW.
Registered Offices: Clutha House, 10, Princes Street, Westminster, London, S.W. 1

G. R. TURNER, LTD.
Manufacturers of all descriptions of
IRON AND WOOD FRAME WAGONS
For Home, Colonial and Foreign Railways.
WHEELS & AXLES.
PERMANENT WAY MATERIALS, &c.
Colliery Screening and Conveying Plants. Engine, Tipping Elevators, Structural Work, Roofing Castings of all descriptions.
Chief Works & Office: LANGLEY MILL, nr. NOTTINGHAM.
London Office: 32, Victoria Street, Westminster, S.W. 1.
Illustrated Advert. first issue in each month on page 8.

BOILER COVERINGS.
96% SAVING.
SUTCLIFFE BROS & BRYCE, Ld.
ATLAS WORKS, GODLEY,
Nr. MANCHESTER
Telephone:—70 Hyde
London Works—
SEAL WHARF, STRATFORD, E. 15.
Telephone:—2127 Broadway.

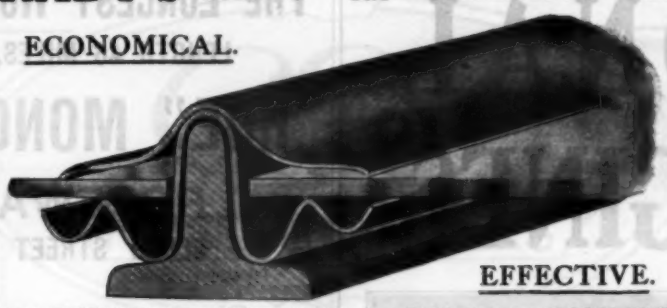
Tel.: Fishponds 116. Teleg.: Sweet, Fishponds, Bristol



STEEL ROOF PRINCIPALS
20 to 50 Feet Span.
Prompt Deliveries from Stock Materials.
Designs and Prices on application to:—
E. W. SWEET & Co., Ltd., Fishponds, Bristol.
Also Makers of Wire Rope Suspension Bridges, Steel Buildings, Staircases, Doors, &c.

T. DAVIES & SON,
RAILWAY IRON WORKS,
WEST GORTON, MANCHESTER.
CUPOLAS & LADLES.

BRABY'S No. 6 "DROP-DRY" GLAZING BAR.
ECONOMICAL.



EFFECTIVE.
Telegrams: "Casuarina, Estrand, London." Telephone: Museum 3033 (5 lines).
352-364, EUSTON ROAD, LONDON, N.W.1, & at GLASGOW, LIVERPOOL, BRISTOL.

HIGH GRADE
STEEL CASTINGS
OF EVERY DESCRIPTION.
To pass Admiralty, Lloyd's, Board of Trade, Bureau Veritas, and other tests.
THOMAS **SUMMERSON** & SONS, LTD.,
DARLINGTON.

SPECIALITIES.
Locomotive Castings.
Railway Carriage & Wagon Castings.
Axleboxes.
Buffer Cases.
Superheater Headers.
Steam Valves.
Electrical Work.

CARELS DIESEL and STEAM ENGINES
See Advt. on page 90.

EXTRUDED BARS
BRONZE YELLOW METAL BRASS **"DELTA" BRAND** (Registered Trade Mark.) RED METAL NAVAL BRASS COPPER
THE DELTA METAL CO., LTD., EAST GREENWICH, LONDON, S.E. 10 AND AT BIRMINGHAM.

LEDWARD & BECKETT, LTD.
PARLIAMENT MANSIONS, VICTORIA ST., WESTMINSTER, S.W. 1
(Opposite Post Office).
Makers of EJECTOR
CONDENSERS
for TURBINES or RECIPROCATING ENGINES.
AUTO. VALVES, VACUUM BREAKERS, ETC.
Catalogues on application.
New Telephone Number: Victoria 3415. Telegraphic Address: Preferment, Vic. London.

Metal-Working Machinery and Machine Tools
Lathes, Planers, Shapers, Drilling Machines, Milling Machines, Boring Mills, Hammers, Saws, Shears, Punches, Bending Rolls, Rivetters, etc.
Write for complete descriptive bulletins
Established 1842 **JOSEPH T. RYERSON & SON** Incorporated 1888
NEW YORK BUFFALO CHICAGO, ILL., U.S.A. ST. LOUIS DETROIT
Cable Address: Ryerson, Chicago. Telegraphic Codes: Bentley's, Western Union (5 Letter and Universal Editions), Lieber's, A. B. C. (5th Edition), Ryerson.
British Representative—Leo C. Steiale, 1, Earl Street, Westminster, London, S.W. 1, England

"I have seen several different forms of Mr. Boyle's 'Air Pump' Ventilator in actual operation, and have much pleasure in testifying to their efficiency."—LORD KELVIN.
OVER ONE MILLION IN USE.
Boyle's LATEST PATENT "AIR-PUMP" VENTILATOR
FOR BUILDINGS AND SHIPS.
HAS DOUBLE THE EXTRACTING POWER OF EARLIER FORMS.
Awarded the £50 Prize with Grand Diploma (only prize offered) at the International Ventilator Competition, London. Highest Award, International Ventilator Competition, Paris, Two Gold Medals.
"Mr. Boyle's complete success in securing the required continuous upward impulse is testified to by high authorities."—GOVERNMENT REPORT (Blue Book).
ROBERT BOYLE & SON,
VENTILATING ENGINEERS,
64, HOLBORN VIADUCT, LONDON.
"Messrs. Robert Boyle and Son, the founders of the profession of Ventilation Engineering, have raised the subject to the dignity of a science."—REPORT ON THE VENTILATION OF THE LONDON CUSTOM HOUSE.

J. & E. HALL, LTD,
Makers of CO_2 and NH_3
Refrigerating Machines and **Hallford Motor Vehicles**
19, St. Swithin's Lane, London, E.C.; 81, Dale Street, Liverpool, and Dartford, Kent.

HIGH CLASS MACHINE TOOLS — HULSE & CO. LTD. ORDSALL WORKS MANCHESTER — SPECIAL & STANDARD
See Illustrated Advertisement, Dec. 8th, page 32.

ROYLES LIMITED,
Engineers and Specialists,
IRLAM, MANCHESTER.
FEED WATER HEATERS, AIR HEATERS, OIL COOLERS AND HEATERS, CALORIFIERS, CONDENSERS, HEATING BATTERIES, KETTLES, STEAM AND GAS, TWIN STRAINERS FOR PUMP SUCTION.
Filters, Steam Traps, Reducing Valves, &c.

CAST IRON PIPES
1½in. to 12in. Bore for EVERY PURPOSE.
THOMAS ALLAN & SONS, LTD.
BON LEA FOUNDRY,
THORNABY-ON-TEES.

Specify—
JOHN GIBBS & SONS' "PEERLESS" Blower & Exhaust FANS and you will NOT be disappointed.
SEND FOR CATALOGUE.
724, Duke Street, Liverpool.
For large advt. see Dec. 15.

USE
'EMPIRE' AUTOMATIC CONTROL GEAR.
See Display Advt., page 82, Dec. 8
ELECTRIC CONTROL LIMITED
GLASGOW.

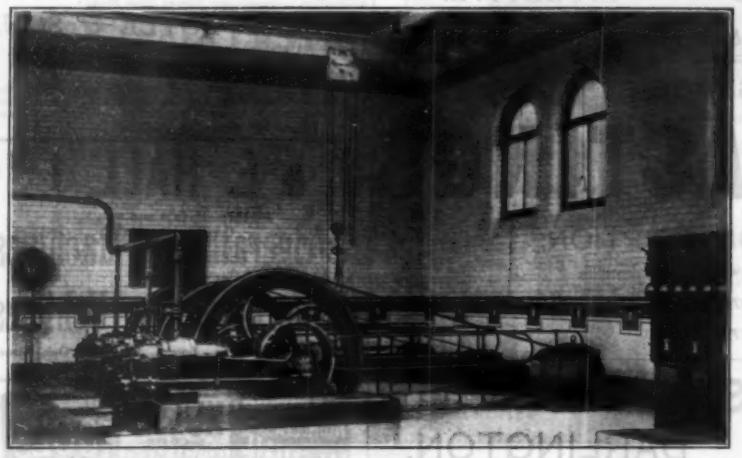
J&S
SMALL TOOLS.
Best by Test.
STRAIGHT SHANK
48 Models
400 Sizes

Write for List 18.
A. A. Jones & Shipman LIMITED LEICESTER

CASTINGS
FOR ENGINEERS
UP TO 12 TONS.
GEORGE JONES, Limited,
Lionel Street, Birmingham.

Kenyon's
PATENT
Oil Filter
AND
Water Separator
Over 900 ordered by H.M. Govt.
ALEXANDER KENYON & Co., Ltd.,
Victoria Bridge,
MANCHESTER.
Engineers' Stores, Tools.

NATIONAL GAS ENGINES



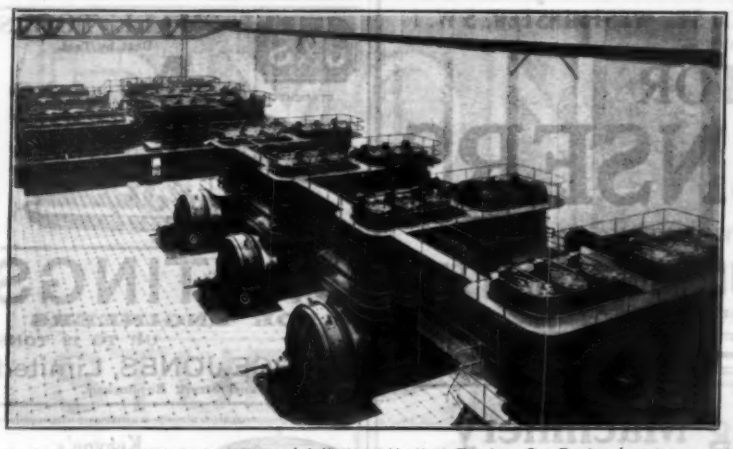
A Gas Works Installation of one 34 and two 20 B.H.P. National Gas Engines Operating on Town's Gas.

NATIONAL Gas Engines are manufactured in Standard sizes up to 1500 B.H.P., and are suitable for operation on all kinds of gases. They are so designed as to secure accessibility to all bearings and working parts, and the general provisions are such that the effects of wear, the amount of gas and lubricating oil consumed, ease of cleaning, and other important features in the working of a gas engine are on the most efficient lines.

Upwards of 50,000 National Engines (totalling millions of horse power) have been supplied, and are giving excellent results in all parts of the World.

If you are requiring power, write us for catalogue and quotation.

We also extensively manufacture Oil Engines and "Gold Medal" Suction Gas Plants.

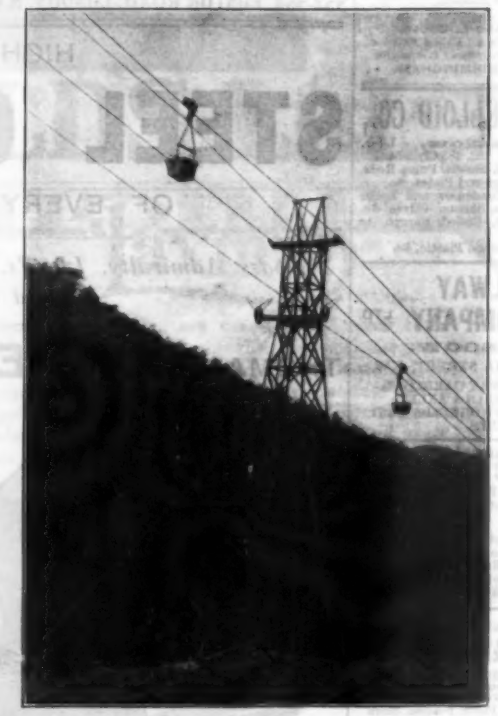


An Iron and Steel Works Installation of National Vertical Tandem Gas Engines consisting of four 1500 B.H.P. Engines and D.C. Electrical Generators, and Three 1500 B.H.P. Engines and Reciprocating Blowers, Operating on Blast Furnace Gas.

THE NATIONAL GAS ENGINE Co., Ltd.
ASHTON-UNDER-LYNE, Nr. MANCHESTER.
Telegrams: "National, Ashton-under-Lyne."
London Office: 75a QUEEN VICTORIA STREET, E.C. 4.

THE LONGEST ROPEWAY IN THE WORLD,
LENGTH 46 MILES, IS CONSTRUCTED ON THE
"ROE" MONOCABLE SYSTEM
ROPEWAYS LIMITED,
ELDON STREET HOUSE, LONDON, E.C. 2.

Telegrams: ROPEWAYS, LONDON. Telephone: CENTRAL 12780

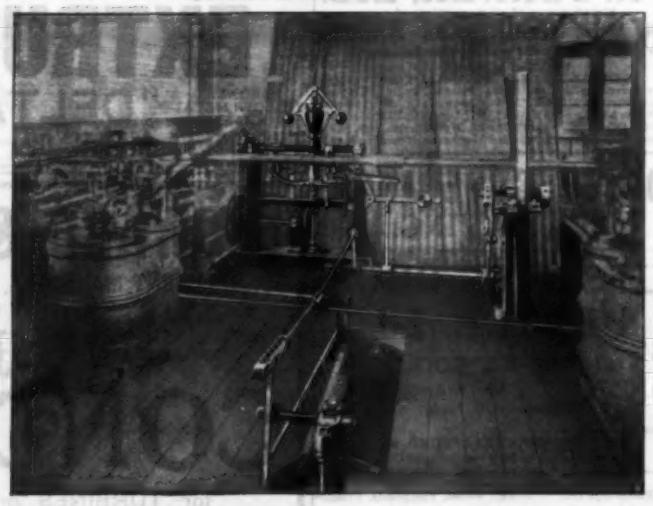


Example of Roe's Bi-Cable System.

Constructors of Aerial Ropeways, Cable Conveyors, etc., for all purposes and of all types.

Also at 3, Plaza Circular, BILBAO, Spain.

THE
"EXHALL" OVERWIND PREVENTER
(JACKSON & STALEY'S PATENTS.)



SPECIAL FEATURES INCLUDE :—

1. Complete control during the whole of the wind.
2. Effectual safeguard of cages during winding of men.
3. Can be set to trip later when winding water.
4. Impossible to start in the wrong direction.
5. Simple design and easily fitted to existing engines.

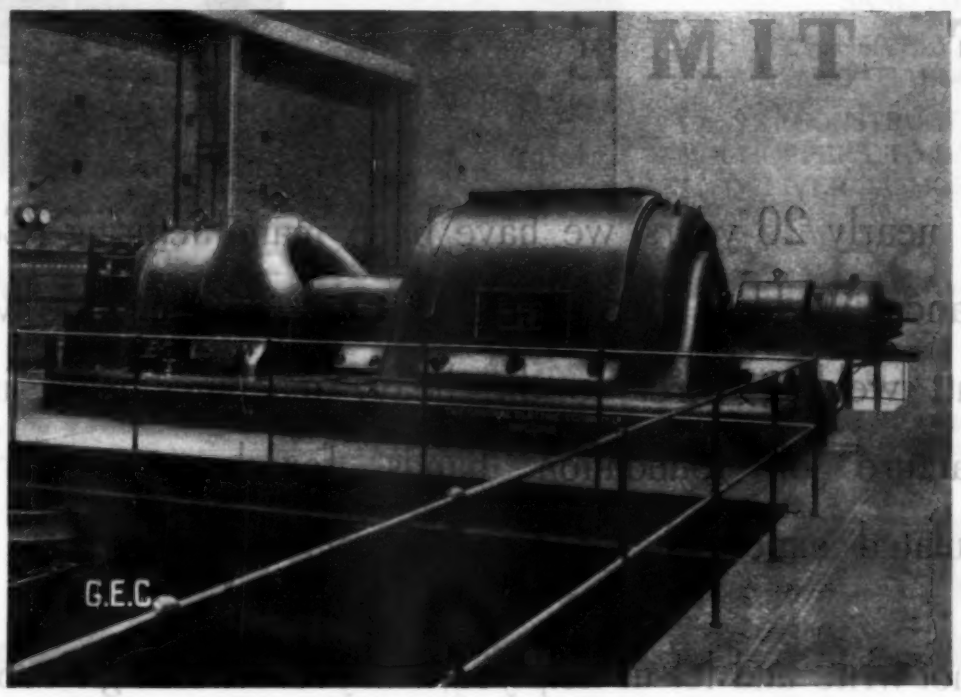
Write for Descriptive, Illustrated List No. 8.

M. B. WILD & Co. LTD.
NECHELLS, BIRMINGHAM.

Telephone: Birmingham, East 208. *Codes:* A B C (5th Ed.), Liebers, Bentleys. *Telegrams:* 'Hauling,' Birmingham.

GEC
FRASER & CHALMERS

TURBO-PLANT



8,000 K.V.A. G.E.C.-F. & C. Turbo-Alternator Set, installed at a large Lancashire Municipal Power Station. 6,000 volts, 50 cycles, 3,000 r.p.m.

The association of Fraser & Chalmers Engineering Works with the G.E.C. places this Company in the position of manufacturing complete Turbo-Power Plant units within its own organisation.

TURBO-ALTERNATORS
up to 30,000 k.w. per unit.
TURBO-GEARED D.C. GENERATORS.

TURBINE or ELECTRIC DRIVE
for MILLS in every Industry.

High, Low, Mixed-Pressure & Pass-out Types
"RATEAU" STEAM TURBINES.

The products of the G.E.C. and its associated factories embrace the entire mechanical and electrical equipment of power plant in practically every sphere, including:—

POWDERED FUEL FIRED BOILERS.
COAL & ASH HANDLING PLANT.
A.C. & D.C. GENERATORS.
ROTARY CONVERTERS.
MOTOR GENERATORS.
SWITCHBOARDS & SWITCHGEAR.
STEAM & ELECTRIC WINDING ENGINES.
ELECTRIC HAULAGE GEAR.

THE GENERAL ELECTRIC CO., LTD.

Head Office: Magnet House, Kingsway, London, W.C. 2.

Engineering Works - - - { WITTON WORKS, BIRMINGHAM.
Fraser & Chalmers Engineering Works, Erith, Kent.

PRESCOT WELDERS

HAVE STOOD THE TEST OF TIME.

For nearly 20 years we have been manufacturing Contact Resistance Welders for all purposes, from the little welder for butt welding wires to the heavy machines used in the manufacture of foundation bands for lorry tyres. This accumulated experience is at your service.

Why not write and let us help you with your Welding Problems?

BRITISH INSULATED AND HELSBY CABLES, LTD.

Cablemakers and Electrical Engineers.

Head Office: PRESCOT, Lancs.

Works: PRESCOT, Lancs, and HELSBY, near Warrington.

Branches in:—London, Manchester, Glasgow, Birmingham, Leeds, Newcastle, Cardiff, Dublin, Belfast, Melbourne, Calcutta and Johannesburg.

GWYNNES'

"INVINCIBLE"

SUCTION DREDGERS

"Invincible" Suction Dredger at work, cutting its own floatation.

Complete Plants Supplied for

Dredging & Reclamation,

Paddock & Claypit Dredging.

Hydraulicing Pumps & Monitors.

THE MOST ECONOMICAL SYSTEM OF SAND DREDGING.

USED EXTENSIVELY BY THE PRINCIPAL DOCK AND HARBOUR AUTHORITIES.

PLANTS CONSTRUCTED TO DELIVER TO OWN HOPPERS, TO BARGES ALONGSIDE, OR TO DELIVER ASHORE THROUGH PIPES

GWYNNES ENGINEERING CO., LTD.,

(GWYNNES LTD.),

Telegrams: *Gwynne, London.*

Hammersmith, LONDON, W. 6.

Telephone: *Hammersmith 1910.*

Contractors to the Admiralty, War Office, Indian and Colonial Offices, and the principal Foreign Governments.

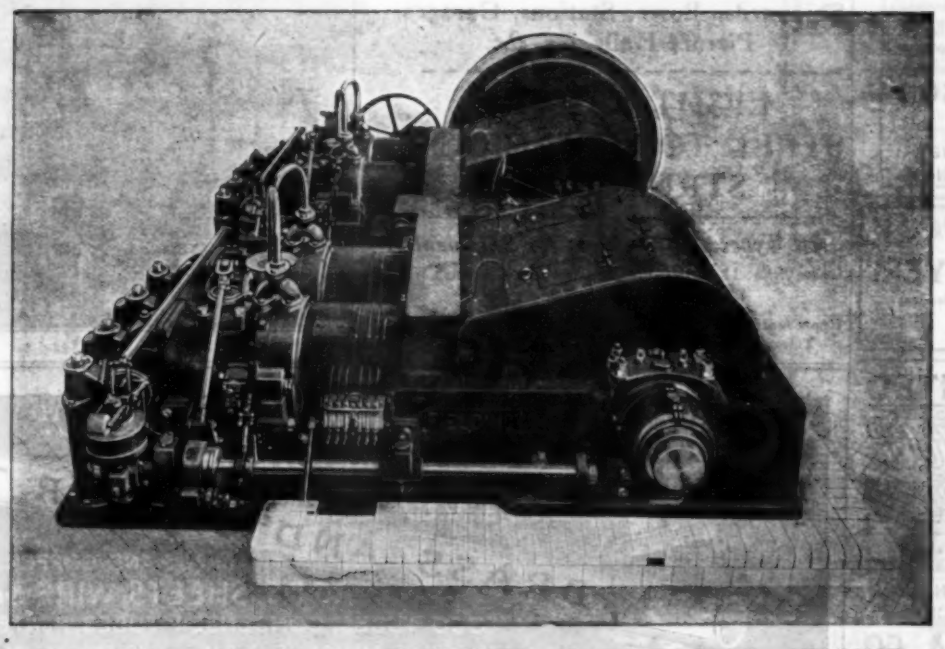
FIELDING ENGINES

SUCTION GAS

THOUSANDS WORKING.

GRADUATED GOVERNING
STEADIER RUNNING

15 B.H.P. TO 400 B.H.P.



400 B.H.P. Maximum FIELDING Suction GAS ENGINE working with Gas from WOOD WASTE.

Direct connected to Dynamo for Power Distribution.

CRUDE OIL

CHEAPEST POWER KNOWN.

Consumption under
½LB. PER B.H.P. HOUR

25 TO 160 B.H.P.

Catalogue Free.

Send cost and size of your present engine; we will tell you saving possible.

FIELDING & PLATT, LD. GLOUCESTER.

AITON & CO. LTD. DERBY.

FLANGED PIPES,
STEEL & CAST IRON, for all purposes.

THE
ANDERSTON FOUNDRY
CO., Ltd.,
100, CHEAPSIDE STREET, GLASGOW.
And at MIDDLESBORO'

Makers of
STATIONARY STEAM ENGINES,
DRY VACUUM PUMPS,
AIR COMPRESSORS,
WIRE WEAVING MACHINERY,
TEXTILE MACHINERY, and
GENERAL ENGINEERS.
Telegraphic Address "Afco, Glasgow.

Wm BAIN & Co Ltd
LOCHRIN IRON WORKS COATBRIDGE SCOTLAND
Manufacture Structural Steelwork, Roofs, Bridges, Light Railway Material, Fencing.
(See last week's advt.)
African Branch: 3-4, New Club Bldgs., Loveday Street, Johannesburg.

THE 1922
BAKER
OIL SEPARATOR
FOR EXHAUST
STEAM
HAS NO EQUAL
CATALOGUE FROM:
DEPT "C" BAKERS (LEEDS) LIMITED,
HUNSLET,—LEEDS.

PERFORATED METALS
WIRE WORK
NAME PLATES
OF EVERY DESCRIPTION.
W. BARNS & SON.
GLOBE WORKS,
Queensland Rd. Holloway.
LONDON. N.

BRICK MACHINERY
BENNETT & SAYER,
Engineers, Ironfounders and General Millwrights,
DERBY.

BERTRAMS LIMITED
SCIENNES EDINBURGH
Paper Mill Machinery
Heating and Ventilating
DUST EXHAUSTING, DRYING, &c.,
EXPERTS. KEEN PRICES.
W. E. BROWNING & CO.,
Cowley Works, Leytonstone, E.

JOHN OAKEY & SONS, LIMITED.
MANUFACTURERS
GENUINE EMERY.
EMERY CLOTH.
GLASS PAPER, BLACK LEAD.
EMERY
CORUNDUM
GARNET &
FLINT
TAPE
FLINT AND GARNET PAPER.
N.B.—All Papers and Cloths are supplied in Rolls, Bands, Discs, Strips, and Sheets of almost any size and shape, to suit the special requirements of buyers. Prices quoted on receipt of particulars.
EMERY AND CORUNDUM DISCS
Of Cloth & Paper, for all Disc Grinding & Polishing Machines
EMERY WHEELS
WELLINGTON WORKS, WESTMINSTER BRIDGE ROAD, LONDON, S.E. 1.

WRIGHT, ANDERSON & CO., LTD.,
Constructional Engineers,
Phone: 487 Gateshead.
Telegrams: "CONSTRUCT, GATESHEAD."
GATESHEAD-ON-TYNE.

STEEL FRAMED BUILDINGS
for Engineering Workshops, Sheds, Shipyards, Power Stations, Garages, Picture Halls, &c. &c.
LIGHT BRIDGES,
STEEL TOWERS, CRANE STRUCTURES.
All Types of Structures for Shipment.
London Office: 11, Carteret St., Queen Anne's Gate, London, S.W.1.
Tel.: Victoria 6529.
Representative: WILLIAM SHARP; M.I. Mech. E.
Telegrams: "SHARSTRUC, VICTORIA, LONDON."

The BIRMINGHAM BATTERY & METAL Co. LTD
SELLY OAK, BIRMINGHAM
SEAMLESS AND BRAZED
BRASS AND COPPER TUBES
BRASS AND COPPER
RODS, SHEETS, WIRE &c.
LOCO TUBES, CONDENSER TUBES, PLATES, FERRULES, &c.
TELEGRAMS BATTERY, SELLY OAK
TELEPHONE 151 (3 LINES) SELLY OAK

HARTNESS
FLAT TURRET LATHES
and AUTOMATIC DIES.

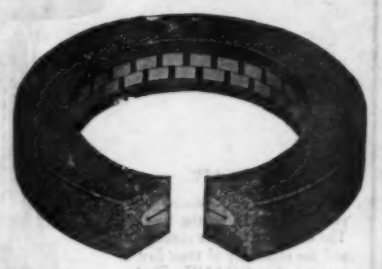
JONES & LAMSON MACHINE CO.,
9 & 10, Water Lane, Queen Victoria Street,
LONDON, E.C. 4.

THE FAY AUTOMATIC LATHE.

The Seal of Beldam's

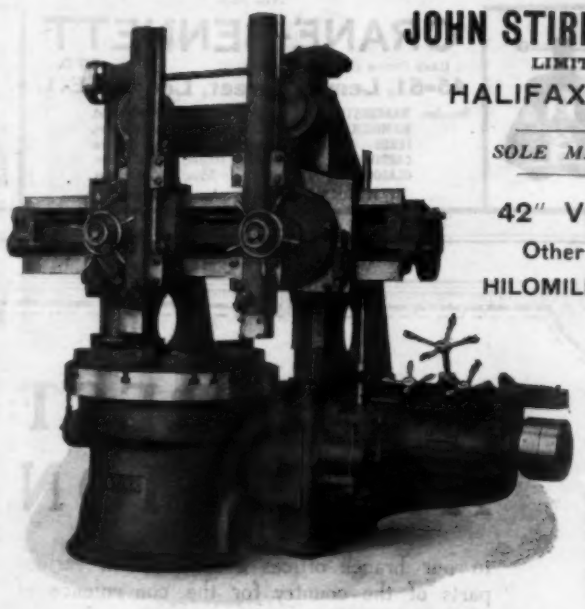
LONDON, PARIS AND NEW YORK
are now manufacturing
BELDAM'S "V" PILOT PACKING

For Steam



or Water.

Sole Patentees and Manufacturers: ESTD. 1876.
THE BELDAM PACKING & RUBBER CO., LTD.,
TELEPHONE—AVENUE 5204 & 1982. 29, Gracechurch Street, LONDON, E.C. 3. TELEGRAMS—"VEEPILOT."
ETAB. BELDAM-LATTY, 63 Rue Taitbout, Paris. THE NEW JERSEY ASBESTOS CO., 1, Water St., New York.

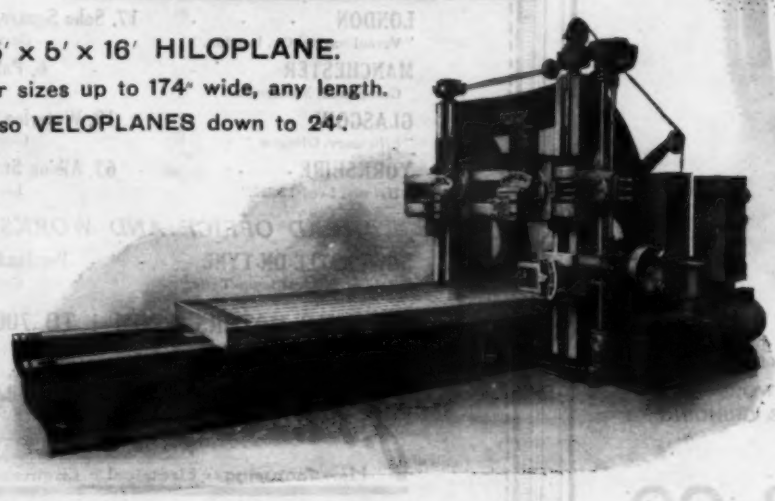


JOHN STIRK & SONS,
LIMITED,
HALIFAX (Est. 1866).
SOLE MAKERS.

42" VELOMILL.
Other sizes and
HILOMILLS up to 192".

STIRK HILO PLANES MILLS
VELO PLANES MILLS
(REGISTERED TRADE MARKS)

5' x 5' x 16' HILOPLANE.
Larger sizes up to 174" wide, any length.
Also VELOPLANES down to 24".



Wrights STEEL WIRE ROPES
Locked Coil, Flattened Strand, Round Strand &c.
See illustrated advertisement in issue of Nov. 3rd

"ASQUITH" DRILLS for VALUE, OUTPUT & DURABILITY.
Enquiries Esteemed. Good Deliveries.
Wm. ASQUITH (1920), Ld.
Highroad Wells, Halifax, England.

JACK'S CRANES.
Electric Overhead Cranes.
Electric Wharf Cranes.
(See large advt., which appears monthly.)
ALEXANDER JACK & CO., Ltd.,
Whitegates Works, Motherwell, Scotland.

H. W. KEARNS & CO., Ld
BROADHEATH, MANCHESTER.
MACHINE TOOLS FOR ENGINEERS.
Tel. No. 221, Altrincham.
See our Illustrated Advertisement in issue of Dec. 15th.

Pure Water — Paterson

FOR EVERY DRIVE REQUIRING A CLUTCH
Use the BENN
FRICTION CLUTCH.
STOCKS IN HAND.
THE
SANDERSON BIBBY CO.,
LIMITED,
36-38, KINGSWAY, W.C. 2.

THE TURBINE (PATENT) FURNACE.
UNIFORM AIR DISTRIBUTION. BALANCED DRAUGHT.
138b, Gray's Inn Road, W.C. 1.
See our illustrated advt. December 15th.
Fitted to any type of Boiler in a few hours. Strict Guarantees. Over 1100 installed.

PEEBLES
Electrical Machinery.
Bruce Peebles & Co., Ltd., Engineers, Edinburgh.

MICHELL BEARINGS, Ltd.,
ENGINEERS & MANUFACTURERS OF
Michell Thrust & Journal Bearings
London Office:
3, Central Buildings, Westminster.
See large Advertisement page 19, Dec. 8th.

See the Mark?
The famous diamond trade mark which has made Jenkins and Valves synonymous terms throughout the world. Look for the mark when buying—it means valve efficiency for you.
72-page catalogue post FREE.
JENKINS BROS., LTD.,
(Dept. E), 6, Gt. Queen Street, W.C.

FINGERS SAVED
IDEAL
SAW GUARDS
CIRCULAR PLANER
CUTTER BLOCKS
M. GLOVER & Co. SPECIALISTS LEEDS.

Contractors to H.M. Government.
HANDLE MAKERS.
BURLEY & SON LTD.,
HORNBY ROAD, BOOTLE, LIVERPOOL.

STEAM CRANES & ELECTRIC
OVERHEAD CRANES.
SAMUEL BUTLER & Co. Ltd.,
Grangefield Works, Stanningley, near Leeds.
"Cranes—" Lifting, Stanningley."
'Phone—176 Stanningley, Private Branch Exchange.

THE CLEVELAND BRIDGE AND ENGINEERING CO. LTD.

Bridge Builders and Constructional Engineers.

SPECIALISTS IN DEEP FOUNDATION WORK.

N.E. Railway Station, Hull.

LONDON OFFICE . . . 123, PALL MALL, S.W. 1.

HEAD OFFICE & WORKS . . DARLINGTON.

TELEGRAMS:— CLEVELAND, DARLINGTON. CLEBRIDGE, LONDON.

TELEPHONE:— No. 2710 DARLINGTON. No. 3427 CENTRAL.

CRANE

1855 1922

WORLD WIDE

Pipe Line Requisites

ECONOMY

Let the first expenditure on your Pipe Lines be the Last. The continuous service obtained and the efficiency of their first cost, make CRANE Pipe Line Requisites factors of ever-increasing Economy in Power Plants and Pipe Lines.

Specify CRANE Fittings

DEPENDABILITY

Do not continue to carry your Power Plant and Pipe Lines on your mind after their installation. Eliminate the fear of failure. Specify CRANE Fittings. Dependability is an inbuilt feature. The satisfactory service obtained from CRANE Valves and Fittings has created a consistent demand from Engineers World-wide.

No. 922.

CRANE-BENNETT

HEAD OFFICE AND WAREHOUSES: LTD.

45-51, Leman Street, London, E.1.

Branches: MANCHESTER . . . . . 32, Oxford Road.
BIRMINGHAM - Lloyds Bank Chambers, New Street.
LEEDS . . . Oxford Chambers, Victoria Square.
CARDIFF . . . The Motor House, Wood Street.
GLASGOW . . . . . 355a, Argyle Street.

WORKS: Nacton Works, IPSWICH.

MACHINE CUT GEARING.

SPUR, BEVEL, WORM, SPIRAL, AND SPROCKET GEARS. RAWHIDE, PAPER AND FIBRE PINIONS. WORM AND SPUR REDUCING GEARS. CASE HARDENING & GRINDING.

THE REID GEAR CO.,

LINWOOD, near PAISLEY.

WE DIRECT ATTENTION

to our branch offices established in various parts of the country for the convenience of customers.

In these branches every client will meet with the personal attention that has always been an outstanding feature of our policy.

BRANCHES:

LONDON - - -	"Vermilionette, Ox, London."	17, Soho Square, W. 1. Gerrard 1228.
MANCHESTER - - - - -	"Compound, Manchester."	6, Pall Mall. City 25.
GLASGOW - - - -	"Efficiency, Glasgow."	19, Waterloo Street. Central 1626.
YORKSHIRE - - - -	"Holmes, Leeds, 26382."	63, Albion St., Leeds. Leeds 26382.

HEAD OFFICE AND WORKS:

NEWCASTLE-ON-TYNE - - -	"Holmes, Newcastle-on-Tyne."	Portland Road. Central 809.

WE MAKE MOTORS FROM 1 TO 700 H.P.

J. H. Holmes & Co NEWCASTLE-ON-TYNE

Manufacturing · Electrical · Engineers

Telephone: Central 809. Telegrams: "Holmes, Newcastle-on-Tyne."

FOWLER
LEEDS.

Cultivating Machinery.
Cable Systems, Tractors, Motor Ploughs.

Road Transport Machinery.
Traction Engines, Road Locos, Wagons.

Road Making Machinery.
Steam Rollers, Scarifiers, Tar-sprayers, &c.

Light Railway Machinery.
Plant, Locomotives, Rolling Stock.

JOHN FOWLER & CO. (LEEDS) LTD.
Steam Plough & Locomotive Works,
LEEDS.
London Office: 113, CANNON STREET, E.C. 4.

Branches and Agencies in every part of the World.

No more Broken Taps!

PAWSON'S TAPPER

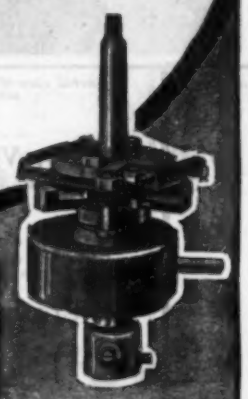
The wonderful new Safety Automatic Tapper, which revolutionises all tapping operations. Works at higher speed than any other tapping device, without fear of breakages.

EVERY USER OF THE PAWSON TAPPER IS ENTHUSIASTIC, as witness :—

Adamant Engineering Co., Ltd., Luton
31st July, 1922.

Dear Sirs,
The Pawson Tapper which you forwarded to us on 14 days' Free Trial has been tested on the component in question, together with the jigs and fixtures, and has proved entirely satisfactory.
A careful estimate shows that its initial cost will be saved on the particular tapping operation for which we put it forward on the first 500 parts tapped.
When its rapidity of action is taken into account coupled with the highly efficient jigs and fixtures used on this production scheme, it will be seen that this is a remarkable achievement, amounting to no less than this :—If the Tapper had been used on the manufacturing job during the fortnight, it would have paid for itself before you ask us to pay for it.
We have pleasure in enclosing our cheque herewith.
Yours faithfully,

Without obligation, will YOU try one of these Tappers? Test one FREE OF CHARGE for a fortnight, and if you cannot corroborate our claims, return it to us carriage forward.



PAWSON & COLLINS,
9, Queen's Gate Works,
KENSINGTON GORE, S.W. 7.

OVERHEAD TRAVELLING PULLEY-BLOCKS

For use with run-ways, lifting and transporting any material. Supplied fitted with geared or un-geared trolleys as shown. Runners fitted with ball bearings at a slight extra cost.

HOLT & WILLETTS
LION WORKS,
CRADLEY HEATH.

Write for illustrated descriptive list.

Ericsson

Telephones

Is your Telephone worth it?

YOU cannot afford to maintain a telephone system that encourages errors, wastes the time of your employees and conduces to general inefficiency.

If your present equipment is giving you trouble, far better to scrap it and next time instal ERICSSON inter-communication equipment which gives you a specialised service, reliable year in, year out. Any electrician will tell you it pays to instal ERICSSON Telephones. Ask the man who uses them.

Illustrated Lists on application.

THE BRITISH L.M. ERICSSON MFG. CO., Ltd.,
67/73, International Buildings, Kingsway, London, W.C. 2.
Works - *BEESTON, NOTTS.*
Telegrams - Ericsson, Holb., London.
Telephones - 5340 Holborn (2 lines).

SELLING AGENTS:
SCOTLAND.—Malcolm Bruce, 57, Robertson Street, Glasgow.
N.E. ENGLAND.—North British Engineering Equipment Company, Milburn House, Newcastle-on-Tyne.

General view of one of the 5 riverside berths at Calcutta for the Calcutta Port Commissioners, solid steel screw piles throughout, total area of floors in sheds 256,000 feet; completed 1922. Braithwaite & Co., Engineers, Ltd., Contractors.

Head Office:
117, Victoria Street, London, S.W.1.

Telegrams: "Bromkirk, Sowest, London."
Telephone: Victoria 8573.

Contractors to the Admiralty, War Office, Council of India, Crown Agents, &c.

Works:
Crown Bridge Works, West Bromwich
Neptune Works, Newport, Mon.

Indian Offices:
Bombay and Calcutta

BRIDGES

ALL TYPES

STEEL FRAME BUILDINGS, PIERS, SCREW PILES, ROOFS, PIPE LINES, &c.

Pressed Steel Trough Flooring

GUTTERS, RAILWAY SLEEPERS, Bunkers, Pit Head Frames, Towers

PRESSED STEEL TANKS

OF ALL SIZES

These tanks can be quickly and easily erected without special tackle or the employment of skilled labour.

BRAITHWAITE
& Co. ENGINEERS Ltd.

KNOWN THE WORLD OVER

THE PEARN PUMP

FRANK PEARN & Co. LD.
MANCHESTER.

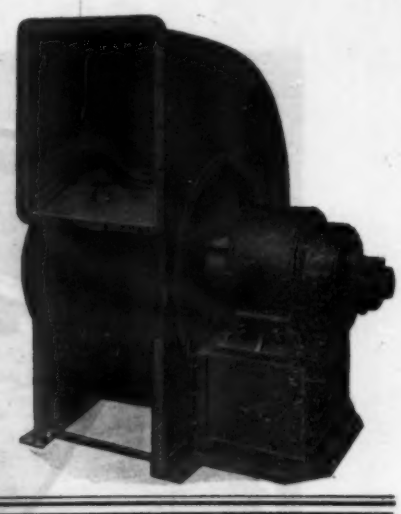
TELEGRAMS: PUMPS, MANCHESTER.
TELEPHONE: 2289 CENTRAL.

London: 40, Queen Victoria Street, E.C.4 ..... **Glasgow: 129, Trongate.**
Liverpool: 33, African House, 6, Water Street. **Cardiff: 24, Park Place**
Newcastle-on-Tyne: 90, Pilgrim Street.
Bristol: 7, St. Stephens Avenue.

The movement of Air & Gas

forms a very important requirement of modern industrial progress, and gives rise to such varied and peculiar problems, that it is only by consulting specialists in this line that vexatious and perhaps costly mistakes are to be avoided. We have specialised for 40 years in the manufacture and application of Air and Gas Moving Apparatus, and have an experienced staff whose advice will ensure the best possible results with economy in first cost and running cost.

Send your enquiries or write for "Fan" Lists to:—
James Keith & Blackman Co., Ltd., 27, Farringdon Avenue, London, E.C. 4,
kindly mentioning "The Engineer."



Keith-Blackman

FANS FOR ALL PURPOSES.

HOWDEN-BURDONS PATENT

OIL-GAS

SYSTEMS

Furnaces for Every Heating Requirement.
Any Type—Any Size—Any Temperature.

BURDONS (K) LTD., Caldervale Works, Bellshill. Nr. GLASGOW.

Ship, Tank, Bridge, On Admiralty and

SIEMENS OPEN HEARTH STEEL

Firebox and Special Plates. Board of Trade Lists.

BOILER PLATES

Soft Welding and Flanging Plates for Furnace and other purposes.

STEWARTS AND LLOYDS, LTD.

41 OSWALD STREET, GLASGOW.

PECKETT & SONS LD.,

TELEGRAMS: PECKETT, BRISTOL.

BRISTOL

Speciality

TANK LOCOMOTIVES

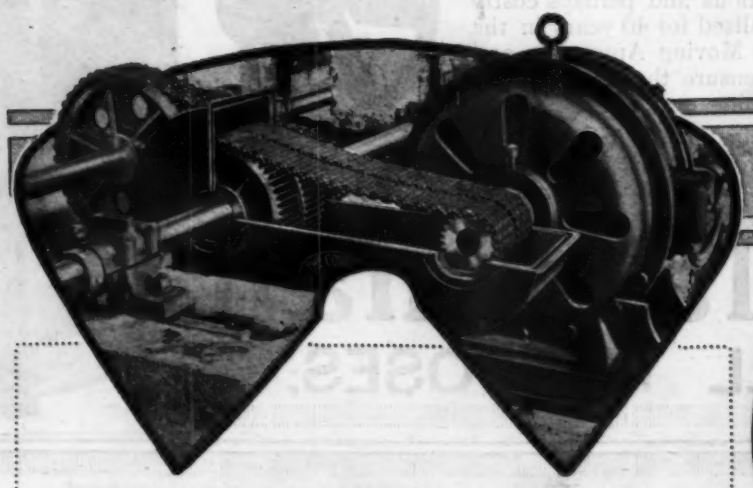
of all Descriptions, and any Size or Gauge.

FULL PARTICULARS ON APPLICATION.

THE BRITISH SPECIALISTS. (ON ADMIRALTY WAR DEPT. AND COLONIAL LISTS)

HYDRAULIC LEATHERS

LEATHERS COMPANY LIMITED ALTRINCHAM.



The Coventry Chains

THE high efficiency of Coventry Chains is of great advantage in reduction drives. The one illustrated is a typical instance. It is in use in a big Sheffield Steel Works, and the reduction is 960/130 in two stages, the first 23/62 T. ¾" 8 × 9, two chains, centres 27", and the second, 17/46 T. 1¼" Triplex Roller No. 261 T., centres 26½".

Other advantages of Coventry Chains include: long life, and absence of slip and vibration.

May we submit facts and figures on the application of the Coventry Chains to some of your own drives? Write us, and we'll send our catalogues first.

THE COVENTRY CHAIN CO., LTD.

Spon End, *Coventry.*

DEPOTS:
LONDON, BIRMINGHAM, MANCHESTER, NOTTINGHAM, GLASGOW, BELFAST, DUBLIN.

"THRAPSTON"

Ball-Bearing Fittings for Line Shafting

Adjustable Vertically. **Automatic Alignment.**

Shaft cannot bind on housing, as in the case of self-aligning ball race when fitted to rigid housing.

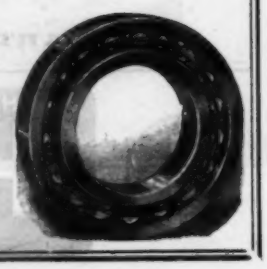
No packing to get height to centre of shaft. **Can be adjusted to finest possible limits with shaft in position.**

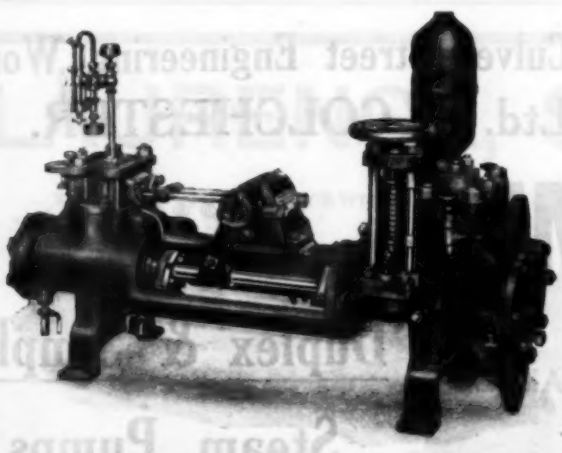
SMITH & GRACE SCREW BOSS PULLEY CO., LIMITED

LONDON:
35, Queen Victoria Street, E.C.

THRAPSTON

Telephone No. 9531 City. Telegrams: "Grace, Thrapston." Telephone: 17 Thrapston.





HORIZONTAL DUPLEX OIL FUEL PUMP FITTED WITH TWELLS' PATENT VALVE MOTION.

HAYWARD-TYLER & CO., LTD

PUMPS

FITTED WITH TWELLS' PATENT VALVE MOTION

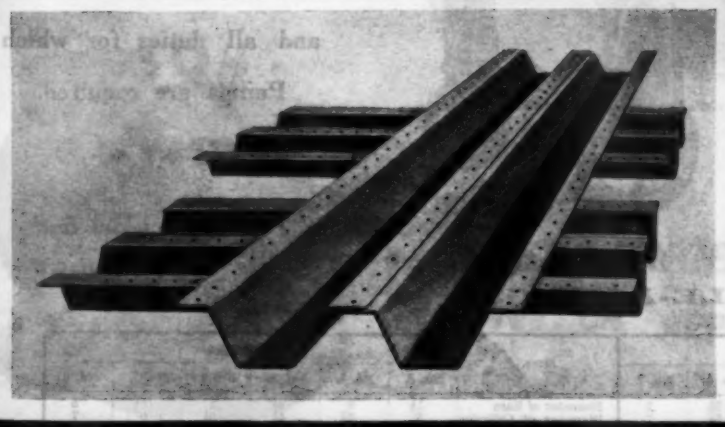
HAVE THE ADVANTAGE OF

A CONSIDERABLE SAVING IN STEAM CONSUMPTION.
A FULL STROKE. SMOOTHNESS IN RUNNING.
A CONTINUOUS FLOW OF LIQUID BEING PRODUCED,
&c. &c.

FOR FULL PARTICULARS APPLY TO—

99, QUEEN VICTORIA ST.,
LONDON, E.C. 4.

Telegrams:
"Tylerox, Cent, London."
Telephone: 9626 City.



TROUGH FLOORING

BLOCKS OF ALL DESCRIPTIONS in Stock.

Pressed in lengths up to 40 ft. *Send for SECTION LIST.*

THE
TEES-SIDE BRIDGE
& ENGINEERING WORKS
LIMITED
MIDDLESBROUGH.

Telegraphic Address:
"TEESSIDE" Middlesbrough.
Telephone: Nos. 21 and 22.

LONDON OFFICE:
17 Victoria Street, S.W.1.
Telephone: Victoria 1613.

CRAVEN BROTHERS (MANCHESTER) LTD.,

Telegrams CRAVEN, REDDISH.

VAUXHALL WORKS,

Telephone: No. 481 HEATON MOOR.

REDDISH, STOCKPORT.

Contractors to the War Office, Admiralty, Colonial and Indian Governments. *Established 1855.*

RAILWAY LOCOMOTIVE WHEEL LATHE

ELECTRICAL DRIVEN DOUBLE RAILWAY WHEEL LATHE with 8ft. 2in. dia. FACEPLATES

A. G. MUMFORD, Ltd.

Culver Street Engineering Works, COLCHESTER.

'Favorite' DONKEY PUMPS

With great improvements for heavy pressures.

GUN-METAL PLUNGERS, VALVES, and SEATINGS.

Very Strong.

Well Finished.

MADE SINGLE & DOUBLE-ACTING.

Also

'Duplex' & 'Simplex'

Steam Pumps.

VERTICAL & HORIZONTAL.

For Boiler Feed, Air and Circulating, and all duties for which Pumps are required.

Full Particulars and Lists on application.

Sizes.	SINGLE ACTING.							
	No. 0.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Diameter of Ram ..	1	1¼	1½	2¼	2¾	3½	3¾	4
Diameter of Cylinder	2	2¾	3	3¾	4½	5½	5¾	7
Length of Stroke ..	2	3	3	4	5	6	6	6
Gallons per hour ..	90	130	210	440	660	1000	1060	1320
N.H.P. of Boiler.. ..	4	8	16	30	45	70	72	90

Sizes.	DOUBLE ACTION.					
	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
Diameter of Ram ..	1¾	2	2¾	3	3¾	5
Diameter of Cylinder	3	3¾	4½	5¾	6	7
Length of Stroke ..	3	4	5	6	6	6
Gallons per hour ..	400	800	1320	1820	2160	4000
N.H.P. of Boiler.. ..	30	70	90	130	180	250

THE DARLINGTON FORGE LTD.

Telegrams: "FORGE, DARLINGTON." DARLINGTON, ENGLAND. Telephone No. 2010.

STEEL & IRON FORGINGS, STEEL CASTINGS,

up to any size or weight

3 THROW MILL ENGINE CRANKSHAFT.
23" dia. x 31' 6" long. Finished weight 40 tons.

REPAIR WORK A SPECIALITY.

LAURENCE, SCOTT & CO., LTD.,

Telegrams: "GOTHIC, NORWICH." NORWICH. Established 1883.
Telephone Nos. 1362 & 1363.

Standard Crane Motor with Magnetic Brake.

Standard Crane Motor.

NEW PRICE LISTS free on application.

Standard Enclosed-ventilated Motor.

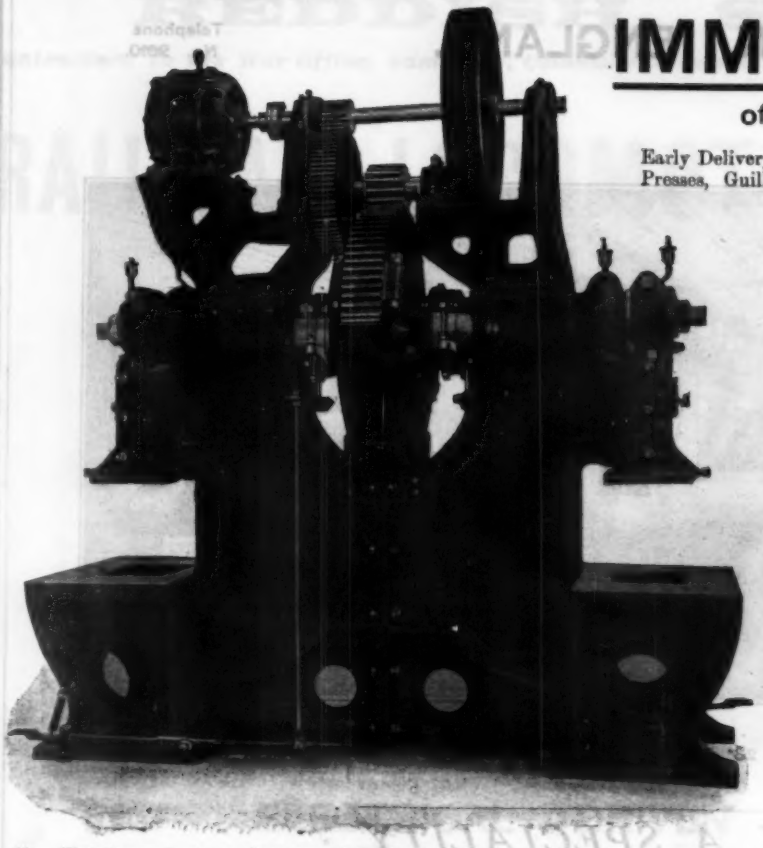
"RHODES" POWER PRESSES

INCLINABLE TYPE. MOST MODERN IN THE WORLD.

IMMEDIATE DELIVERY

of all sizes (Nos. 14½, 18, 19, 20, 21, 21S).

Early Delivery of Double-sided Presses, Punching Presses, Reducing Presses, Drawing Presses, Guillotine Shears, and all classes of Sheet Metal Working Machinery.



Above Illustration represents our latest type Duplex Punching Press arranged for direct motor drive.

"RHODES" HIGH-SPEED SHEARS

to cut 3 feet and 4 feet wide by $\frac{1}{16}$ in. thick, *in Stock*.

OTHER NEW MACHINES IN STOCK, SUBJECT to being UNSOLD :

Set of Smoothing Rollers for Electrical Engineers; Rolls 36in. long, 5in. diam.

No. 43 Special Duplex Geared Punching Press for operating trimming dies for drop stampings.

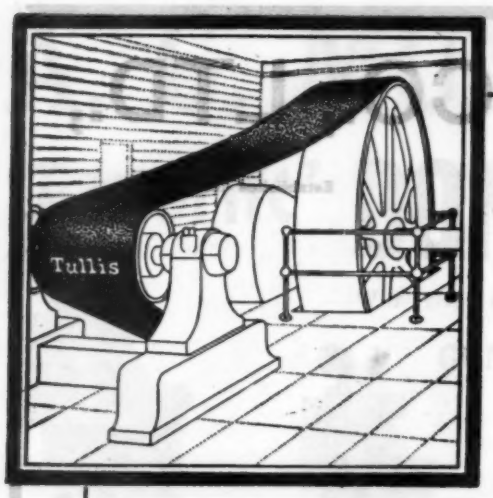
The principal dimensions of the press are :—

Working pressure on slides	75 tons
Standard opening in bed	18 × 12
Centre of slide to back	12"
Maximum distance bed to ram when stroke and adjustment are up	16½"
Standard stroke	3½"
Standard adjustment to ram	1"
Area of bed or table	42 × 26
Cuts per minute	30
Size of hole in ram for tools	3" dia. × 3½" deep
Floor space required	9' × 4' 6"
Height over all	10'
Horse-power required	8
Approx. weight of machine	140 cwt.
" " Motor	5 cwt.
" " Control gear	2½ cwt.

JOSEPH RHODES & SONS, LIMITED.

Estab. 1824,

GROVE IRONWORKS, WAKEFIELD, YORKS.



—regarding Quality!

¶ When trade is *bad* it is a wise policy to buy the very best quality.

¶ When trade is *good* the buyer can afford to experiment with cheap qualities, but in times of depression it is imperative to buy only that which can be relied upon to ensure true economy.

¶ *Tullis* Belting is of a very high grade cut exclusively from that portion of the hide where the fibre is tightest and practically stretchless.

¶ Our whole aim is to sell you not *more* Leather Belting but—the *right* Belting for your particular requirements.—Write us!

Tullis LEATHER BELTING

gives *you* Service.

	Telephones:		Telegrams: (*Consumers.*) (*Export.*)
LONDON—5, Lloyd's Avenue, E.C.	Avenue	1461.	Mahaniba, Fen, London. Tullibody, Fen, London
MANCHESTER—9, Blackfriars Road.	Central	2007.	Tullis, Manchester.
BIRMINGHAM—17, Cannon Street.	Central	307.	Tullis, Birmingham.
LEEDS—10, Aire Street.	Central	25095.	Tullis, Leeds.
NOTTINGHAM—Trent Navigation Bldg., Wilford Street,	Nottingham	1259.	Olive, Nottingham.
BRISTOL—39, Broad Street.	Bristol	5435.	Tullis, Bristol.
BELFAST—30a, Queen Street.	Central	4232.	Tullibody, Belfast.
DUBLIN—9, Lower Sackville Street	Dublin	975.	Tullis, Dublin.
JOHANNESBURG—15-18, Central House.	J'burg	8905.	Chonais, J'burg.

Tullis "Columbia" for Main or Heavy Driving.
Tullis "Orange Tan" for Electrical or Fast Running.

JOHN TULLIS & SON LTD.,

— *BELTING SPECIALISTS,* —

ST. ANN'S WORKS, GLASGOW.

Telephone: Bargeddon 1205, 6, 7, 8 (Private Branch Exchange).
Telegrams: "TULLIS, GLASGOW."

LIFTING TACKLE

OF EVERY DESCRIPTION.

DERRICK OR CARGO GIN WITH HOOK.

1650 TRADE MARK. REGISTERED 1922

OVERHEAD TRAVELLING RUNNER

ALLDAYS & ONIONS, LTD.,

(Established 270 years)

BIRMINGHAM.

Birmingham Telephone: VICTORIA 487. Telegrams: "ALLDAYS, BIRMINGHAM."

LONDON OFFICE & SALES DEPT.: 40-44, Holborn Viaduct, E.C.1.

Telephone: HOLBORN 2032 (2 lines). Telegrams: TYPHOON, CENT.

TRAVELLING BLOCK.

TRIPOD JACK.

WIRE ROPE PULLEY BLOCKS.

SCREW BLOCK.

HOT ACIDS, SLURRY AND TRADE WASTE

is Automatically lifted by means of

ADAMS' PAT. EJECTORS.

OPERATION CAN BE ARRANGED FROM EXISTING POWER PLANT thus reducing cost of working to a minimum.

An Engineering Firm writes:—

"With reference to the four Adams' Sewage Ejectors we beg to state that we are pleased with them in every way. We have found them simple, fool-proof, quick and reliable and they have given every satisfaction."

ADAMS HYDRAULICS LTD., ENGINEERS, YORK,

And ADAMS HOUSE, OLD QUEEN STREET, WESTMINSTER.

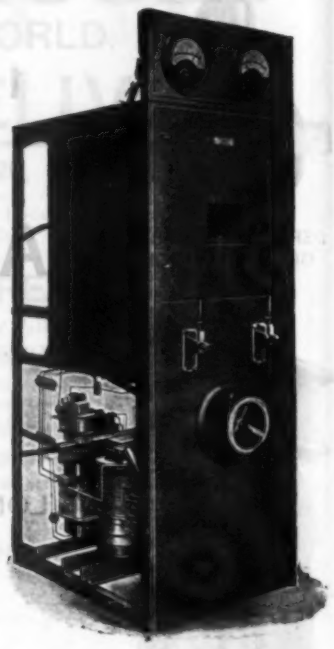
TELEPHONE—47 YORK and 935 VICTORIA, LONDON
TELEGRAMS—"SANIFERA," All Branches.

STATIC CONVERTING PLANT

(MERCURY VAPOUR RECTIFIERS)

for

SUB-STATIONS & WORKS



ALL CAPACITIES.

Call and See the Rectifiers in our Showrooms.

HEWITTIC ELECTRIC Co., Ltd.,
80, York Road, King's Cross, London, N.1.

Telephone :— North 624 & 625.
Telegrams :— "Hewittic, Kincross, London."

HEAD, WRIGHTSON & COMPANY LIMITED.

ENGINEERS AND IRON FOUNDERS.

OIL STORAGE TANKS

STRUCTURAL WORK OF EVERY DESCRIPTION.

BRIDGE CYLINDERS, TUNNEL SEGMENTS, &c.

STEEL, IRON AND BRASS CASTINGS.

OUTPUT of FOUNDRIES - - - - - - - - - - 100,000 TONS PER YEAR

TEESDALE IRON WORKS, THORNABY-ON-TEES.

Telegrams: TEESDALE, STOCKTON-ON-TEES.

ALSO STOCKTON FORGE WORKS, AND ECCLESCLIFFE FOUNDRY, STOCKTON-ON-TEES.

IMPORTANT NOTICE.

To safeguard the best interests of all concerned in

EXCAVATING SAND, GRAVEL, ETC., AND REMOVING OVERBURDEN.

We desire to announce that we possess the Sole Manufacturing Rights for the British Isles of the

SAUERMAN PATENT DRAGLINE EXCAVATOR

AND

SAUERMAN PATENT POWER SCRAPER

(FULLY COVERED BY BRITISH PATENTS.)

Sauerman Patent Excavators are the outcome of many years' successful experience in handling material. You are respectfully warned against imitations.

The services of our Expert Engineers are at your disposal for the solution of your material handling problems. We solicit your kind enquiries.

LIDGERWOOD, LTD., FRIAR HOUSE, NEW BROAD STREET, LONDON, E.C. 2.

Telegrams: LIDGERWOOD, LONDON. Telephone: LONDON WALL 7422.

Clayton Wagons, Ltd.,

Telephone: 650 LINCOLN.
Telegrams: "Abbey, Lincoln."

Clayton & Shuttleworth, LTD.

Telephone: 760 (4 lines).
Telegrams: "CLAYTONS, LINCOLN."

Lincoln, England.

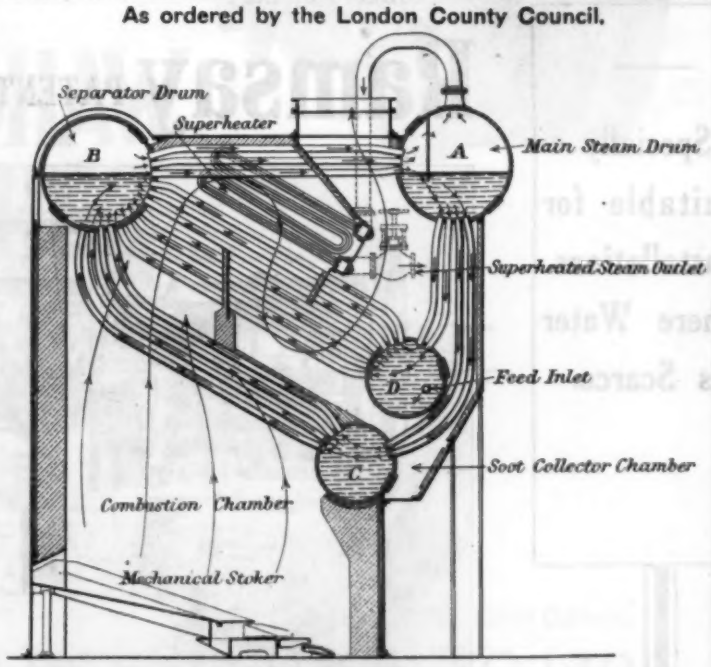
RAILWAY ROLLING STOCK

PULLMAN CARS. CORRIDOR CARS.
PASSENGER COACHES.

Contractors for Railway Wagons of every description in Steel and Timber for Home, Colonial and Foreign Governments and Railways.

WATER TUBE BOILERS

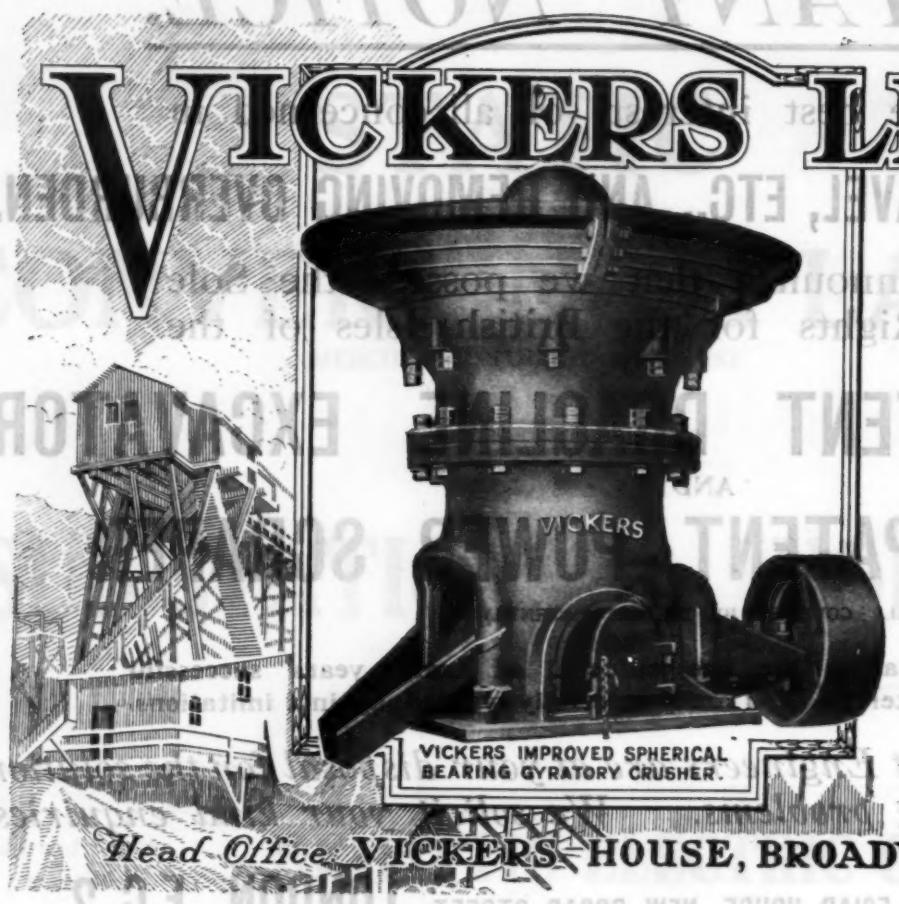
As ordered by the London County Council.



Evaporation up to 150,000 lbs. water per hour.

London Office: 38, Victoria Street, S.W.1
Manchester Office: 61/62, Millgate Buildings, Long Millgate.

VICKERS LIMITED



VICKERS IMPROVED SPHERICAL BEARING GYRATORY CRUSHER.

JAW & GYRATORY ROCK BREAKERS.

BALL OR TUBE MILLS.
PULVERISERS & CONVEYORS.

Manganese Chrome or other Special Castings and Forgings for Renewal Parts. Cement Making Machinery of every description. Complete Plants, including Power Installations, Designed, Constructed and Erected.

Head Office: **VICKERS HOUSE, BROADWAY, LONDON. S.W.1.**

FULLERTON, HODGART, & BARCLAY, LTD
PAISLEY

Codes:
A B C 5th Edit.
Engineering,
Western Union
Marconi Inter.

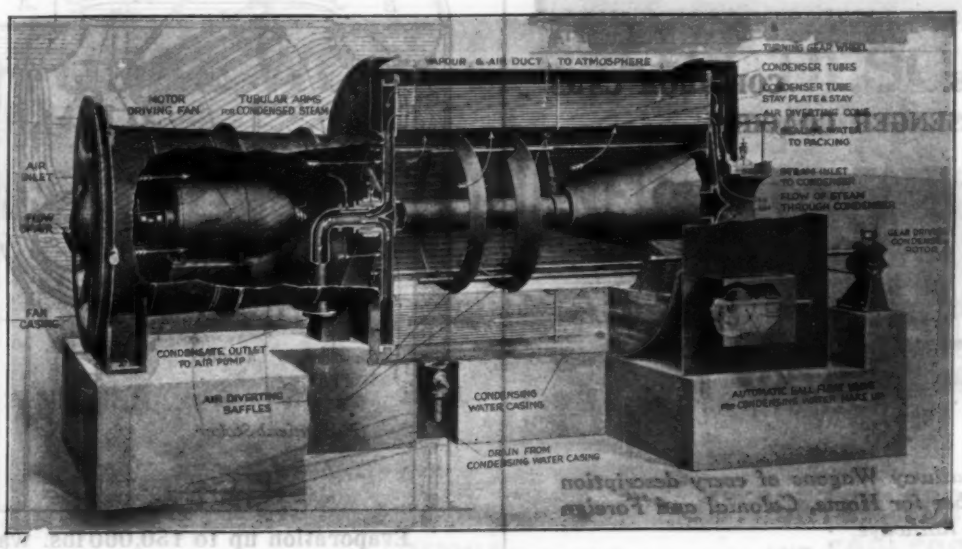
Telephone:
2163-4 Paisley
(Private Branch Exchange)
Telegrams:
"Vulcan, Paisley."

ESTABLISHED 1838.

Makers of the :—

Specially Suitable for Installations where Water is Scarce.

Ramsay PATENT Condenser



Capable of Condensing 1lb. OF STEAM with 1lb. OF WATER and Maintain Vacuum up to 28 INCHES.

Full particulars on application.

Fullerton

STANDARD FAN.

CUPOLA FAN.

FORGE FIRE FAN.

DUST FAN.

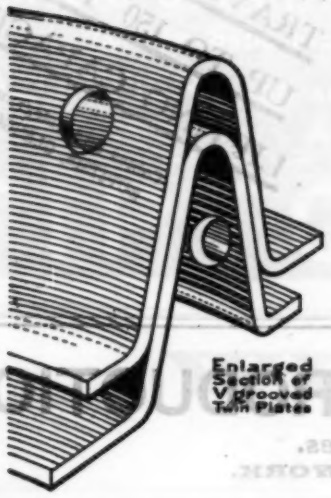
THERE IS A

Centrifugal Fan for every purpose for which a Fan can be employed.

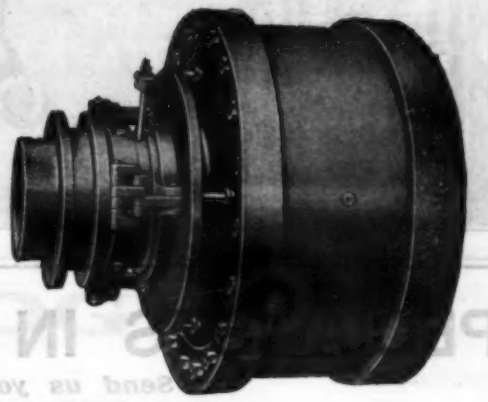
DAVIDSON & COMPANY, LIMITED,

Sirocco *Engineering Works,* **BELFAST.**

LONDON: Central House, Kingsway, W.C.2.
MANCHESTER: 54, Corporation Street.
BIRMINGHAM: Exchange Buildings, New Street.
GLASGOW: 53, Bothwell Street.
CARDIFF: Principality Buildings, Queen Street.



COUPLINGS & PULLEYS
FOR ALL POWERS
AND ALL SPEEDS

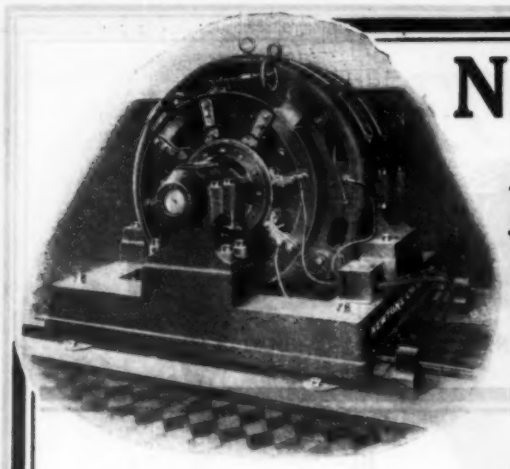


HELE-SHAW CLUTCHES

ENSURES GRADUAL ENGAGEMENT
EFFICIENT LUBRICATION
ABSOLUTE GRIP
NOT AFFECTED BY DAMP OR DUST.

Telephone No. 1133 OLDHAM. Telegrams "PREHENSION OLDHAM."

THE BRITISH HELE-SHAW PATENT CLUTCH CO., LTD.
OLDHAM, ENGLAND.



NEWTONS *of* TAUNTON

Direct Current

MOTORS & GENERATORS

Designed Right for Power. Constructed for Endurance. Silent—Smooth—and no trouble in Running. Stand big Overloads. Proved Reliable—yet competitive in Price.

Catalogues and Quotations sent with pleasure, on application.

NEWTONS SALES DEPARTMENT.

ROTAX (MOTOR ACCESSORIES), LTD.

(Incorporating Newtons of Taunton),

Rotax Works, Willesden Junction, London, N.W. 10.

Variable Speed Motors a *Speciality.*

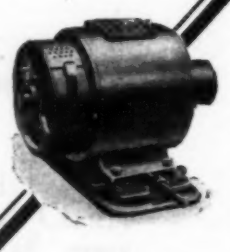
AGENCIES AT YOUR SERVICE:

LONDON & SOUTH-EASTERN COUNTIES: Messrs. Baxter & Causter, Ltd., 219, Tottenham Court Road, W. 1.
MIDLAND COUNTIES: Messrs. Robinson & Hands, Ltd., 54, Berwick Street, Birmingham.
YORKSHIRE: Messrs. Firth & Russell, Sterling Works, Shadton Lane, Holbeck, Leeds.
LIVERPOOL & CHESHIRE: P. Wright, 31, Radcliffe Buildings, 97, Moorfields, Liverpool.
SCOTLAND: Messrs. Andrews & Co., 40, West Campbell Street, Glasgow.
WALES *(excepting N. Sea.)*: W. A. Rodwick, Russell Buildings, St. Mary St. Swansea.
NORTHERN COUNTIES OF IRELAND: Mr. J. Ardrey, 45, High Street, Belfast.
SOUTHERN COUNTIES OF IRELAND: F. W. Parkes & Co., Faraday House, Temple Lane, Dame Street, Dublin.

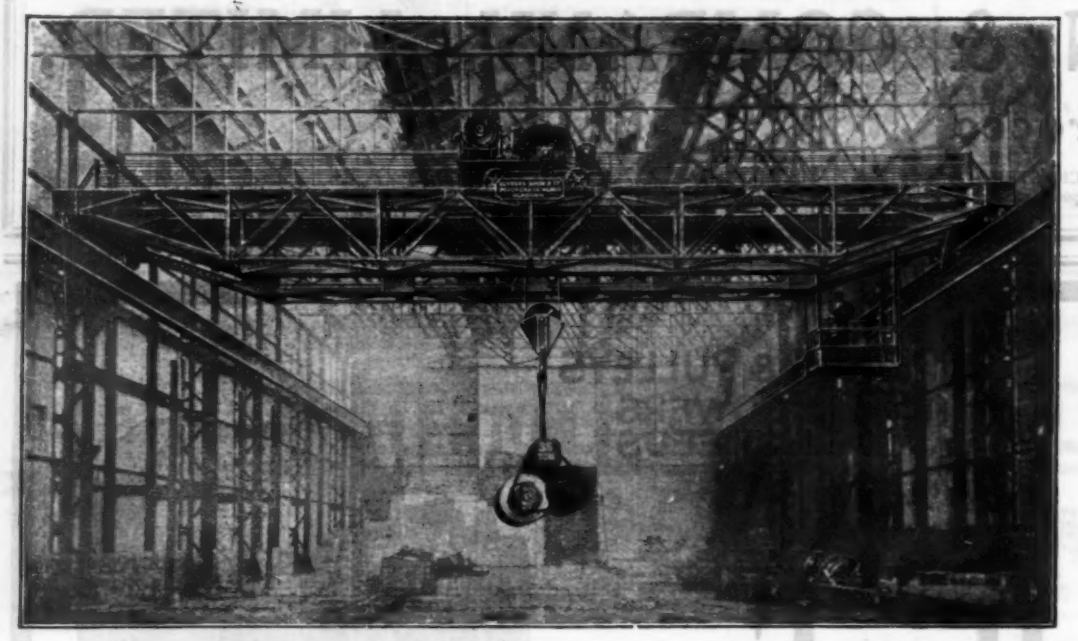
Agency applications are invited for the following Territories, North Wales, Monmouth, Gloucestershire, Part of Oxford and Bucks, Somerset, Wiltshire, Part of Berkshire, Devon, Cornwall and Dorset.

Large or Small
Put in
"NEWTONS"
It Pays.

'Phone: Willesden 2480 Private Branch Exchange.



BUTTERS BROS. & CO., PERCY CRANE WORKS, GLASGOW



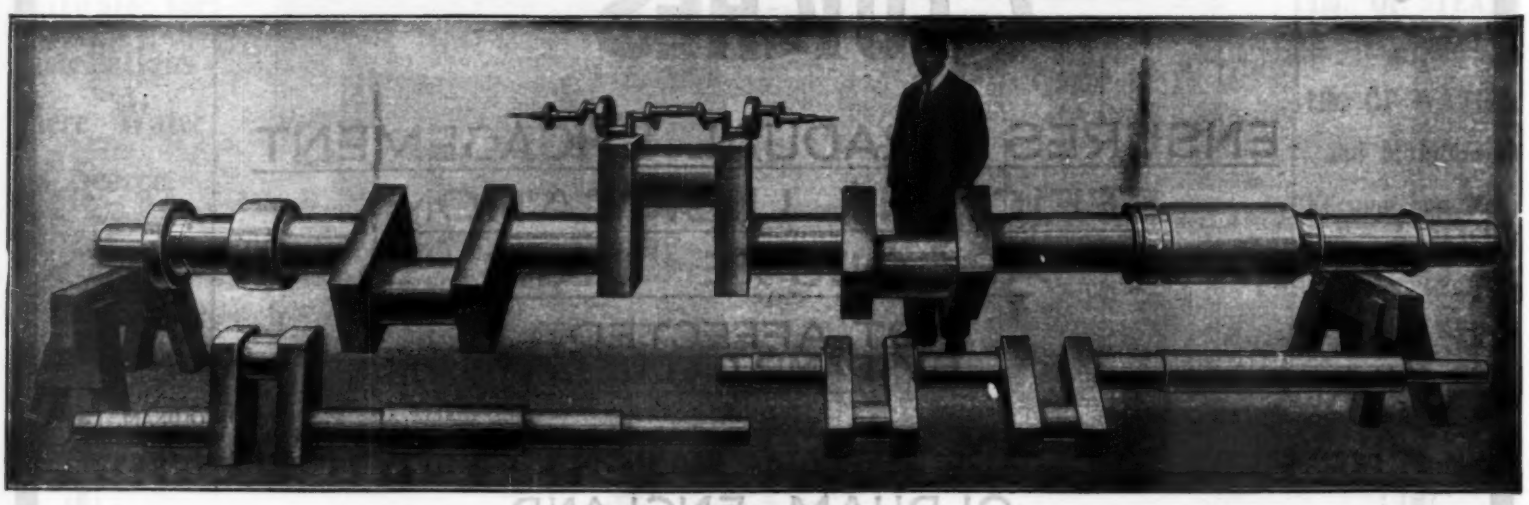
MAKERS OF ALL TYPES OF OVERHEAD TRAVELLING CRANES, UP TO 150 TONS LIFTING CAPACITY.

Cables and Telegrams: BUTTERS, GLASGOW.

SPECIALISTS IN CRANKSHAFT PRODUCTION.

Send us your enquiries for all Types and Sizes.

ALSO GENERAL FORGINGS AND REPETITION WORK.



MITCHELL, SHACKLETON & CO., LTD.,

Tel.: 582 Eccles. Telegrams: Vulcan, Patricroft.

VULCAN WORKS, PATRICROFT.

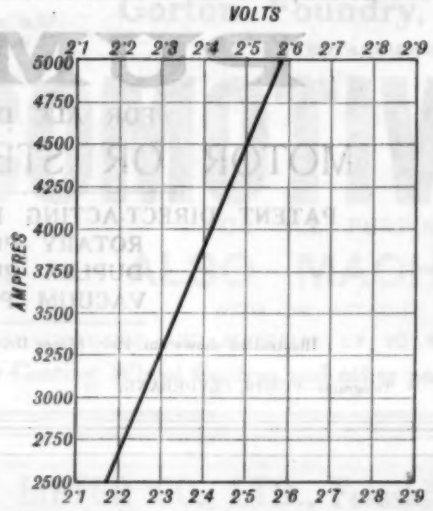
KNOWLES & I.O.C. OXYGEN HYDROGEN GENERATORS

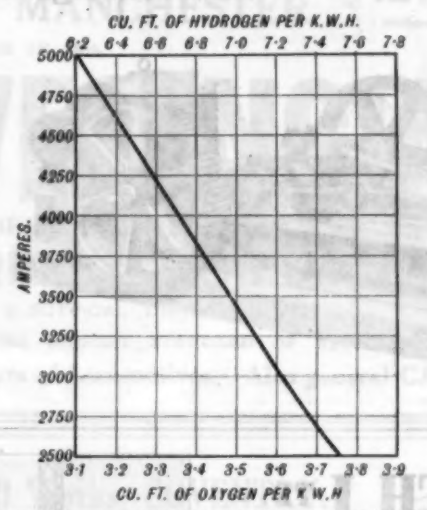
(See "The Engineer," Sept. 29th, 1922.)

HIGHLY EFFICIENT.

SAFE IN OPERATION.

DURABLE.





OXYGEN 99%

HYDROGEN 99·5%

GUARANTEED PURITY.

DIRECT FROM THE CELLS.

CONSUMPTION AND PRODUCTION CURVES FOR 3000 AMPERE NORMAL CAPACITY KNOWLES CELL.

THE INTERNATIONAL ELECTROLYTIC PLANT CO., Ltd., New Crane Street, CHESTER.

WRIGHT'S

Specialities:

WATER SOFTENERS.
Greasy Water Purifiers.

FEED WATER HEATERS.
Types: Berryman and Straight Tube.

HEATER DETARTARISERS.
Grease Separators.

CALORIFIERS FOR ALL PURPOSES.
Sand Filters, &c.

TIPTON,

FORGE AND ENGINEERING Co. LTD.

Send for Catalogue.

FORGINGS IN IRON OR STEEL.
Rough or Finished Machined up to 12 tons.

STRUCTURAL WORK.
Rivetted Pipes and Tanks.

COLLIERY PLANT.
Headgears, Cages, Keps.

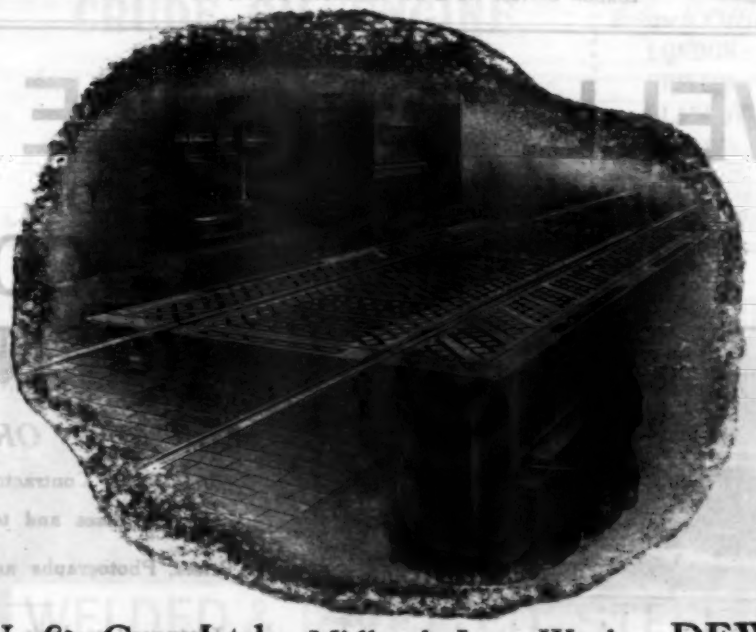
ELEVATORS & CONVEYORS
Detaching Hooks.

STAFFS AND 57, BISHOPSGATE, LONDON.

WEIGHBRIDGES.

WEIGHBRIDGES FOR ROAD & RAIL TRAFFIC.

ANY LENGTH & CAPACITY.



MAKERS OF ALL TYPES OF WEIGHING APPARATUS.

ASHWORTH, SON & Co., Ltd., Midland Iron Works, DEWSBURY, England.

London Office: 11 QUEEN VICTORIA STREET, E.C.

DAWSON & DOWNIE, LTD.

Elgin Works, CLYDEBANK.

PUMPS

FOR ALL DUTIES.

MOTOR OR STEAM DRIVEN

PATENT DIRECT-ACTING BOILER FEED PUMP
ROTARY PUMPS
DUPLEX PUMPS.
VACUUM PUMPS

Illustration shows our Hor. Motor Driven TREBLE RAM PUMP

Telegrams—PUMPS, CLYDEBANK. Telephone—92-93 CLYDEBANK.

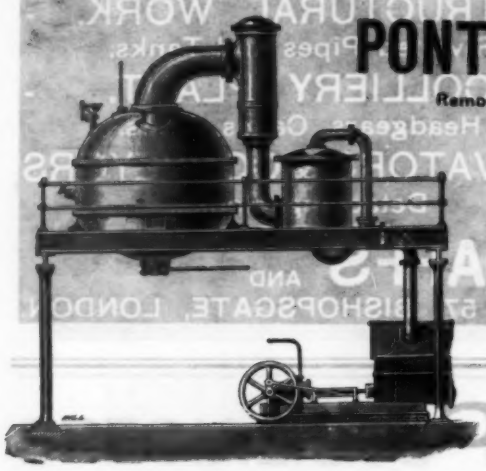
HILL & SMITH, LTD.

Constructional Engineers,

BRIERLEY HILL, STAFFS.

Steel Framed Buildings
Roof Principals Bridges
Girders .. Gantries
Runways .. Hoppers

STRUCTURAL STEELWORK of every description.



PONTIFEX & WOOD, LTD.,

Removed from Farringdon Works, Shoe Lane, London, to

UNION FOUNDRY,
DERBY.

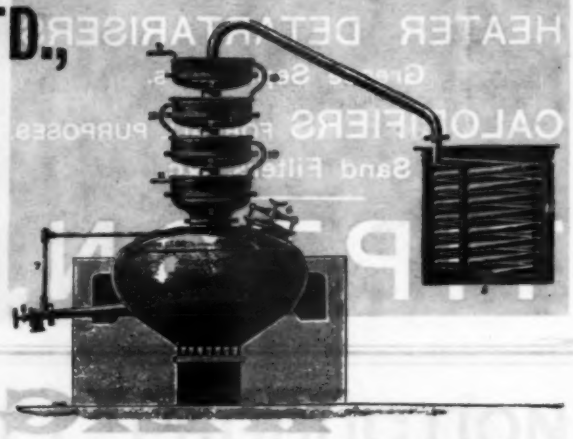
COPPERSMITHS

Makers of all kinds of

Copper Work for Brewers and Distillers.

Milk Condensing Plants.

LONDON OFFICE: 175 to 177, SALISBURY HOUSE, E.C.



ESTABLISHED 1860.

HUDSWELL, CLARKE & CO., LIMITED.

RAILWAY FOUNDRY, LEEDS.

LOCOMOTIVE ENGINES

FOR MAIN OR BRANCH RAILWAYS.

Docks, Contractors, Steelworks, Collieries, &c.

All Sizes and to suit any Gauge of Railway.

Prices, Photographs and full specifications on application.

Telegrams—Loco, Leeds. Telephone—National 20993.
Codes—A 1, Lieber's, A B C (4th and 5th Editions).

BEYER, PEACOCK & CO., LTD.

London Representative—
E. S. LUARD, M.I.C.E.,
15, Dean's Yard, Westminster, S.W.
Tel. Address—FOLGORE, VIC, LONDON.
Tel. No.—3987 Victoria.

Gorton Foundry, MANCHESTER.

ESTABLISHED IN 1854.

Works Telegraphic Address—LOCO, GORTON.
Telephone Nos. Manchester Central 5663 & 5664.
Two Lines.

LOCOMOTIVE ENGINES

FOR ALL PURPOSES AND GAUGES.

GARRATT PATENT ARTICULATED LOCOMOTIVES.

ALSO MACHINE TOOLS.

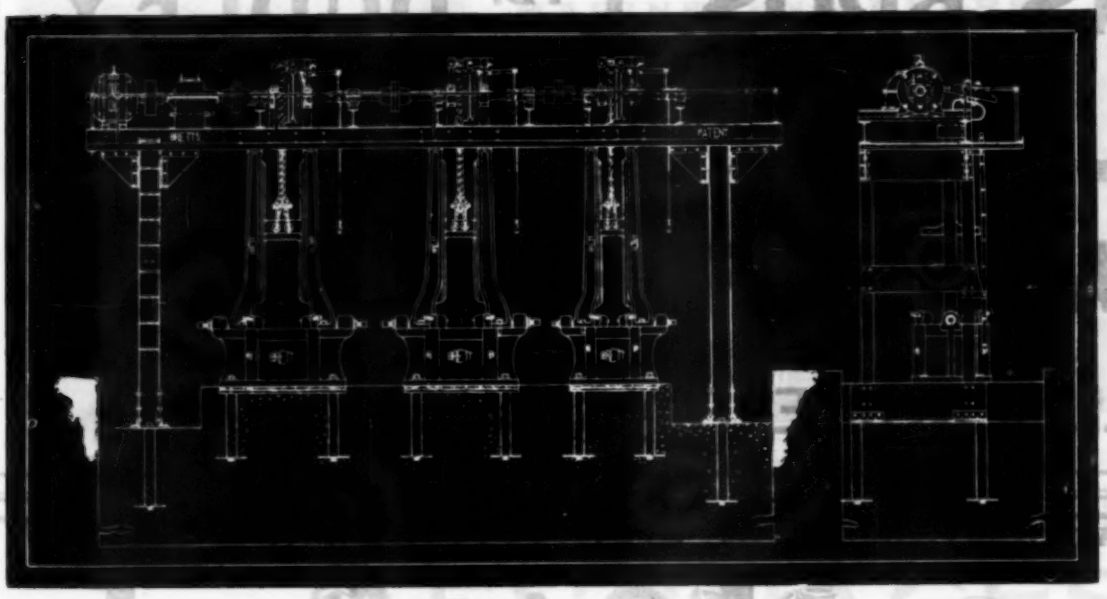
EMERY GRINDING MACHINES A SPECIALITY.

WITH OR WITHOUT ELECTRICAL DRIVE.

WORKMANSHIP AND MATERIAL UP TO THE HIGHEST STANDARD OF EXCELLENCE.

STEEL FOUNDRY for Casting Wheel Centres and other parts of Locomotives. Also general CASTINGS & FORGINGS

BRETT'S PATENT LIFTER CO., LTD., Foleshill Works, COVENTRY.

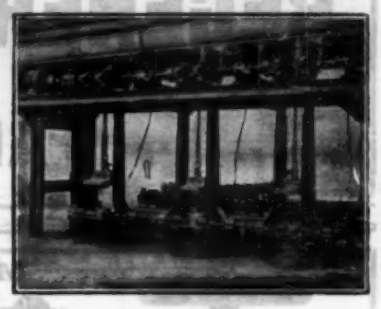


BRETT

DROP HAMMERS for *Sheet Metal Spoon & Fork & Holloware Stamping.*

Bring your plant up to date by

Installing BRETT Hammers.

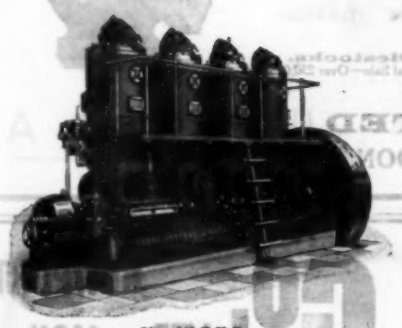


Actual Battery in Operation

VICKERS-PETTER OIL ENGINES

INDUSTRIAL AND MARINE.

SIZES UP TO 500 B.H.P.



Size 340 B.H.P.

The
PIONEER SEMI-DIESEL CRUDE OIL ENGINE.

Low Fuel and Lubricating Oil Consumption.

LOW PRICES. QUICK DELIVERY.

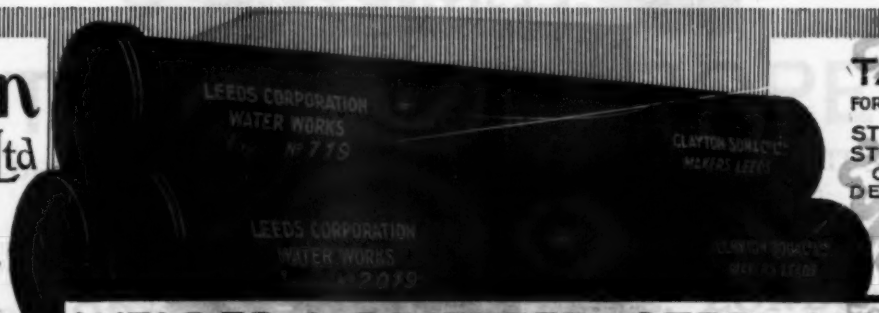
VICKERS-PETTERS, Ltd.
IPSWICH, ENGLAND.

Branch Offices and Showrooms:—
LONDON: 75b, Queen Victoria St., E.C. 4.
BRISTOL: 140, Victoria Street.
GLASGOW: 163, Hope Street.
DUBLIN: 30, Lower Sackville Street.

Petter Engines are also manufactured from 1½ B.H.P. upwards for working on Paraffin, Petrol or Town's Gas. Particulars on application to Petters Limited, Yeovil.

Clayton Son & Co Ltd Leeds

Telegrams "GAS LEEDS"
London Office
5 VICTORIA ST. S.W.1.



TANKS
FOR OIL, WATER &c.
STRUCTURAL STEELWORK OF EVERY DESCRIPTION
Gasholders & Gasworks Plant Boilers &c.

WELDED & RIVETTED STEEL MAINS

JOHN THOMPSON (WOLVERHAMPTON) Ltd., WOLVERHAMPTON.

The "JOHN THOMPSON" "DISH-END" BOILER.

IMMEDIATE DELIVERY

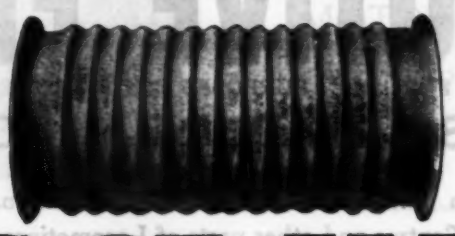
6 30ft. x 9ft. 3in. x 160 lbs. W.P.
1 30ft. x 9ft. 3in. x 150 lbs. W.P.
2 30ft. x 9ft. 3in. x 120 lbs. W.P.
2 30ft. x 8ft. 6in. x 120 lbs. W.P.
1 30ft. x 8ft. 3in. x 175 lbs. W.P.
1 30ft. x 8ft. 3in. x 160 lbs. W.P.

CORRUGATED SECTIONS (FOR LAND & MARINE BOILERS).

"FOX" OR "MORRISON" TYPE,

WITH OR WITHOUT "GOURLAY" ENDS.

THE TRADE SUPPLIED.



STANDARD SIZES FOR IMMEDIATE DESPATCH.

BOILERS OF ALL TYPES.

GIBBONS BROS. LTD. DUDLEY.

Telegrams—"GIBBONS, LOWER GORNAL." *CONTRACTORS TO ADMIRALTY AND WAR OFFICE.* Telephone—40 DUDLEY.

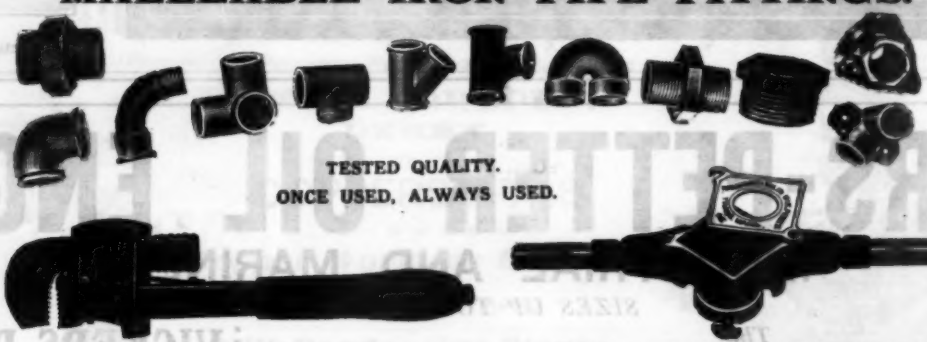
PATENTEES AND BUILDERS OF

REGENERATIVE MUFFLES & FURNACES

FOR

ALL ENGINEERING WORK.

MALLEABLE IRON PIPE FITTINGS.



TESTED QUALITY.
ONCE USED, ALWAYS USED.

Genuine Stillson Wrench. 3 sizes, for ½ to 5 inch pipe. (Annual Sales – Over One Million.)

Genuine Walworth Diestocks. 45 ranges, 0 4 inch iron and conduit pipes. (Annual Sale—Over 250,000.)

ILLUSTRATED CATALOGUE ON APPLICATION.

H. MUNZING, LIMITED (DEPT. E.)

Head Office: 90/96, UNION STREET, SOUTHWARK, LONDON, S.E. 1.

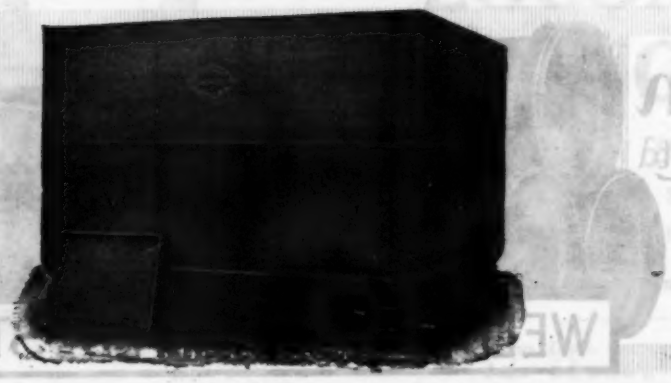
Also at 209, BERKELEY STREET, GLASGOW.

THE ISCA FOUNDRY CO. LTD. NEWPORT, MON.

LONDON OFFICE: 53, VICTORIA STREET, S.W

Telegraphic Address ISCA, VIC. LONDON: ISCA, NEWPORT.

FOR RAILWAY SWITCHES AND CROSSINGS CHAIRS



TANKS WATER CRANES, BUFFER STOPS, TURNTABLES BRIDGES, ROOFS, HYDRAULIC SIGNALS, FLANGE PIPES, & SOCKET CASTINGS &c.

Telephone: Central 9280.

DAVID COLVILLE & SONS LD.

Telegrams: "Colvilleit," Glasgow.

DALZELL STEEL IRON WORKS, MOTHERWELL.
GLENGARNOCK WORKS, GLENGARNOCK. CLYDEBRIDGE WORKS, CAMBUSLANG.
HEAD OFFICE: 195, WEST GEORGE STREET, GLASGOW.

DALZELL STEEL — BOILER BRAND.

DALZELL STEEL — SHIP & BRIDGE BRAND

DALZELL FOUNDRY PIG IRON — "DALZELL" BRAND.

DALZELL NICKEL STEEL — NICKEL STEEL BRAND

PLATES, RAILS, JOISTS & BARS.

IN SOFT, MILD, MEDIUM, HIGH TENSILE, H.H. TENSILE, NICKEL AND ALLOY STEEL.

Makers of Highest Quality Scotch Foundry Pig Iron, "Dalzell" Brand.

JOHN BROWN & CO., LTD.,

S.S. AQUITANIA on the Slips

SHIPBUILDERS,
MARINE ENGINEERS,
STEEL MANUFACTURERS.

London Offices:
8, The Sanctuary, Westminster, S.W.1.
Telegrams: "ALDWARKE, LONDON."

ATLAS WORKS, SHEFFIELD,
& CLYDEBANK, NEAR GLASGOW.

Telegrams: "Atlas, Sheffield."

Telegrams "Shipyard, Clydebank."

Rolled Turbine Drum, Weight 25 Tons.

AUGUST'S MUFFLE FURNACES LTD. HALIFAX.

FURNACES

For ANNEALING, HARDENING, CASE-HARDENING, TEMPERING, RE-HEATING, Etc., and PRACTICALLY ALL PURPOSES TO MEET CUSTOMERS SPECIAL REQUIREMENTS.

PATENT CORE & MOULD DRYING SYSTEM

ALREADY INSTALLED FOR MANY LEADING FOUNDRIES TO NEW AND EXISTING OVENS.

PORTABLE MOULD DRYERS.

A CORE OIL REGISTERED KOR-KREME TRADE MARK WITHOUT EQUAL.

Fullest Particulars of our Manufactures on application.

TELEPHONE: Avenue 2108 (3 lines).

BULLIVANT AND CO., LIMITED

TELEGRAMS: "Bullivants (Fen), London."

STEEL WIRE ROPES

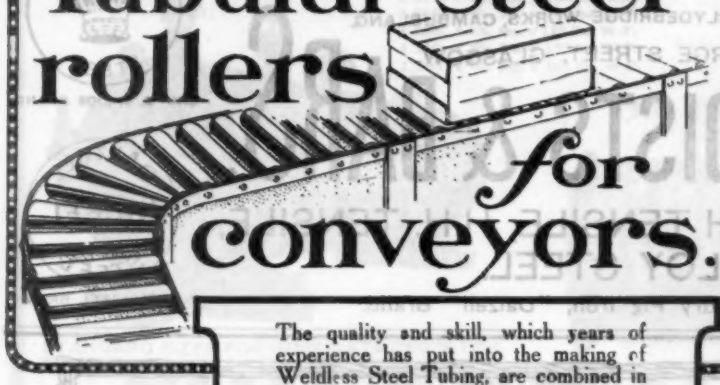
For CRANES, DERRICKS, HAULAGE, SUSPENSION-BRIDGES, CABLE-TRAMWAYS, and
ALL ENGINEERING PURPOSES.

BLOCKS, PULLEYS, CRAB-WINCHES, &c. &c.

Registered Offices: 72, MARK LANE, LONDON, E.C. 3.

Works: MILLWALL, LONDON, E. 14.

Tubular steel rollers for conveyors.



The quality and skill, which years of experience has put into the making of Weldless Steel Tubing, are combined in producing tubular rollers absolutely reliable in every respect. We can supply these in any size to suit your special requirement.

TAPERED TUBULAR ROLLER FOR CURVED TRACK.

PARALLEL TUBULAR ROLLER FOR STRAIGHT TRACK

Our tubing is also used in making the following articles:
Trolley Poles for Tramcars.
Kerbside Petrol Pumps and Fittings.
Electrical Transformers.
Tubular Box Spanners.
Weldless Steel Tubing, plain or manipulated for all engineering purposes.

Send for our Catalogue of Special Sections, which contains full-size illustrations of upwards of 300 different sections and other useful information.

Accles & Pollock, Limited,

Oldbury,
Birmingham.

Makers and manipulators of weldless steel tubing.

ISLES LD.

STANNINGLEY,
LEEDS.

ELECTRIC, STEAM OR HAND

CRANES

of all TYPES and SIZES.

HEAD OFFICE: *'Phone: 45 STANNINGLEY.*
Telegrams: "ISLES, STANNINGLEY."

LONDON OFFICE: 91/93, Windsor House, Victoria St., London, S.W. 1.
'Phone: 4149 VIC. 'Grams: "DREDGEABLE."

CARDIFF OFFICE: 50, Charles Street.
'Phone: 2808. 'Grams: "INNOCENCE."

MANCHESTER OFFICE: 9, Albert Square.
'Phone: 5252 CITY. 'Grams: "KELVIN."

BLACK AND BRIGHT

BOLTS AND NUTS
&
RAILWAY FASTENINGS

OF EVERY DESCRIPTION.

THE "HELICOID" LOCK-NUT

MADE FROM ¼in. TO 2½in.

PRICES ON APPLICATION.

Also Manufacturers of Iron and Steel Bars, numerous Sections, Iron Fencing, Railings, Gates, &c.

CATALOGUES FREE.

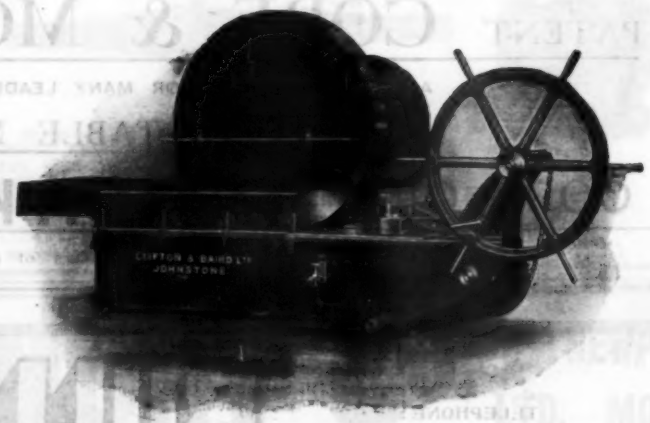
BAYLISS, JONES & BAYLISS,
LIMITED,

WOLVERHAMPTON.

And 139 & 141, CANNON STREET, LONDON, E.C. 4.

High Speed

Friction Sawing Machine



An essential for Steel Works, Shipyards, Structural Builders, &c., for rapidly cutting all kinds of Steel Sections. Only 25 seconds required to cut through a 12in. by 3½in. channel, and finishing off in such a clean manner that the material can be used right away for structural work of the highest class. In the construction of the machine the saw is mounted direct on the motor spindle, thus giving a vast saving in power and upkeep over those driven by belt or chain. The Hand Gear has proved itself much superior to any other form of feed gear.—Mechanical, Electric or Pneumatic.

Further particulars on application

Clifton & Baird
LIMITED

Empress Works, Johnstone, Scotland.

Branch Offices:

Associated British Machine Tool Makers, Ltd., London, Birmingham, Manchester, Newcastle, Bristol, Sheffield, Leeds, Etc.

STEAM & ELECTRIC

LAUNDRIES

Modern Machines for Commercial Laundries, Hospitals, Homes, Hotels, Railway Companies, Steamships.

A Thoroughly Reliable Job Guaranteed. Estimates Free.

D. & J. TULLIS, LTD.

Steam Laundry Engineering Specialists,

CLYDEBANK, N.B.

MONEL METAL

The Premier Engineering Material for withstanding—

Superheated Steam,
High Temperatures,
Salt Water,
Alkaline Solutions,
AND
Many Acids and Chemicals.

Strong as steel and is the toughest metal known.

Hot and cold rolled bars and sheets, etc.

Forged valve seats for superheated steam.

G. & J. WEIR, LTD. Monel Dept. CATHCART GLASGOW.

WIRE ROPES

MANUFACTURERS OF

FLEXIBLE AND SPECIALLY FLEXIBLE WIRE ROPES FOR ALL PURPOSES.

LARGE STOCKS HELD FOR IMMEDIATE DELIVERY.

We invite inquiries on all questions concerning WIRE ROPES, and are prepared to place our expert knowledge and advice at the disposal of users.

ILLUSTRATED CATALOGUE WILL BE SENT ON REQUEST.

ALLAN, WHYTE & Co., Ltd.

CLYDE PATENT WIRE ROPE WORKS,

RUTHERGLEN, GLASGOW.

Telegrams & Cables "ROPERY, RUTHERGLEN" Telephones: 5165 CENTRAL, 3473 BRIDGETON.

London Office - 1, EAST INDIA AVENUE, E.C.3.

TELEGRAMS: ALWHYTROP, STOCK, LONDON.
TELEPHONE: 869 CITY.

CONTRACTORS TO ADMIRALTY, WAR OFFICE, COLONIAL and FOREIGN GOVERNMENTS.

STEEL STRUCTURES

ROOFS, BRIDGES, TANKS.

CLYDE STRUCTURAL IRON Co. LD.

CLYDESIDE IRON WORKS,

Telegrams: CORRUGATED, GLASGOW.

SCOTSTOUN,

Telephones: WESTERN 2952-2953.

GLASGOW.

OTHER FOLKS' OPINIONS.

In *Engineering*, July 25th, 1919, details were published of Mr. Brownlie's test of 1000 boilers, and we give below his best case with 5 Lancashire Boilers alongside the results received from a client relative to a private test with 4 Yorkshire Boilers. This client is now using 26 Yorkshire Boilers.

Four 24ft. × 9ft. 4in. Yorkshire Boilers / One 30ft. × 9ft. Lancashire Boiler / Four 30ft. × 9ft. 6in. Lancashire Boilers	Five Lancs.	Four Yorks.
Total hourly evaporation in lbs. from and at 212°	55,444	61,053
Evaporation per lb. of Coal burned	9·5	10·08
Clinker and Ash, per cent.	11·5	17
Evaporation per square foot of firegrate	233 lb.	359 lb.
Terminal Temperature of Gases	412°	352°
Overall Efficiency, per cent.	71·84	78
Evaporation per square foot of floor space occupied ...	20 lb.	39 lb.

SAVING IN FLOOR SPACE MEANS AN ALL ROUND ECONOMY.

HOLDSWORTH & SONS, LTD.

With which is incorporated the Yorkshire Boiler Co., Ltd.

CROFT BOILER WORKS
LEEDS ROAD
BRADFORD

Catalogues sent on application.

'Phone: 446.

Telegrams: "Steam."

South Wales Office: Gordon Chambers, Queen Street, Cardiff.

"BRAMPTON" CHAINS

The

Modern medium for Power Transmission

POSSESSING the advantages of Belts and Toothed Gearing without the disadvantages of either, **CHAIN GEARING AFFORDS A HIGHER MAINTAINED EFFICIENCY than any other form of transmission,** and great durability.

The positive action of Chains eliminate the leakage of power through slip common with belts, and reduces the pressure on bearings to a minimum as the initial tension required with a belt is unnecessary with Chain.

The multi-tooth engagement of the Chain on the wheels gives a smooth, quiet and even turning movement in the drive, the efficiency of which is not decreased by wear, as against the limited tooth engagement of gear wheels with rapid wear and decreasing efficiency.

The above illustration shows an 80 h.p. Countershaft Drive by **"BRAMPTON"** Inverted Tooth type Chains, with a shaft centre distance of 4ft., and a gear ratio of 3 to 1.

We should be glad to have an opportunity to further discuss the advantages, efficiency and reasonable initial cost of Chain Gearing with you, placing our experience of over 30 years at your disposal, and advise or estimate for your requirements, without obligation.

Meanwhile, let us send you our book "POWER TRANSMISSION BY CHAIN."

BRAMPTON BROS. LTD. OLIVER STREET **BIRMINGHAM**

WIRE

WHITECROSS

ROPES

The Whitecross Company, Ltd.,
WARRINGTON. *Established 1864*

Manufacturers of—
PATENT AND PLOUGH STEEL WIRE ROPES
for Mines, Lifts, Cranes, Shipping, Oil Wells and all purposes.

Guide Ropes, Signal Strands. | Special "WHITECROSS" Brand Hauling and Winding Ropes for Mines. | **Round & Flattened Strand Constructions**

Contractors to The Admiralty, War Office, Crown Agents for the Colonies, Post Office, India Office, Trinity House and Dominion & Foreign Governments.

Telegrams: Whitecross, Warrington." *Telephone: Nos. 9, 10, 11 & 12 Warrington.*

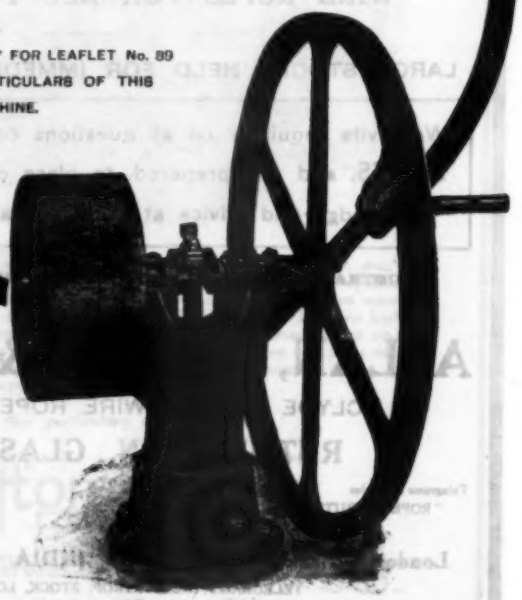
Agents—for the North and South Midlands: BIRAM & CO., 23, Euston Road, London.
" for the Counties of Northumberland and Durham:
WATTS, HARDY & CO., Tyne Street, North Shields.

IMPROVED TYPE

GAS ENGINE STARTING COMPRESSORS.

THE ILLUSTRATION SHOWS OUR LATEST TYPE OF GAS AND OIL ENGINE STARTING COMPRESSOR, ARRANGED FOR BOTH HAND AND BELT DRIVING, FOR PRESSURES UP TO 250 LBS. PER SQ. INCH.

WRITE TO DEPT. "A" FOR LEAFLET No. 89 GIVING FULL PARTICULARS OF THIS MACHINE.



REAVELL & CO. LTD. IPSWICH.

TELEGRAMS: REAVELL, IPSWICH. TELEPHONE: 324 IPSWICH.

What Do You Pay For Your Water?

It is not at all unusual, even in these days when the cost of the most minor of manufacturing operations is carefully scrutinised, to find manufacturers paying comparatively extravagant prices for water.

American Deep Well Turbine installations replace antiquated equipment at savings that amount to literally thousands of pounds a year in labour and power.

THE AMERICAN WELL WORKS

General Office and Works: Aurora, Ill., U.S.A. Chicago Office: First National Bank Building.
Export Office 85, Liberty Street, New York, U.S.A.

Valves FOR HIGH PRESSURE AND SUPERHEATED STEAM.

NICKLOY FACES.

HUNT & MITTON, LTD.

Engineers,
OOZELLS STREET NORTH,
BIRMINGHAM.

Combining
FLETCHER BROS.,
(Late of Ashton-under-Lyne),
The well-known Boiler Mounting Makers, and
SMITH'S INJECTOR COY.
(Late of Nottingham).

"F Type" H/P Bronze Renewable Seated Wheel Valve. Nickloy Valve and Seat.

"BRECO" SYSTEM

Cut your costs with a Ropeway!

View of Ropeway at a Coal Mine.

THE ROPEWAY CUTS YOUR COSTS TO A MINIMUM.

Write for Illustrated Booklet to:—

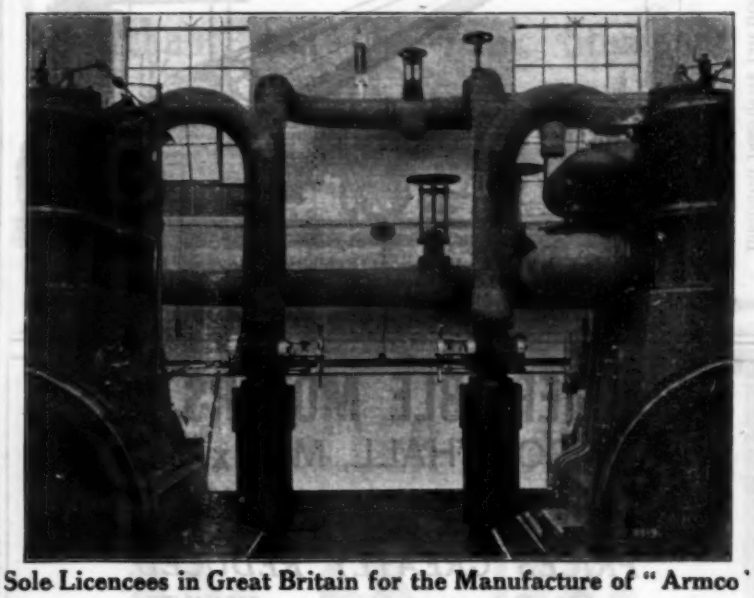
The British Ropeway Engineering Co., Ltd.,
7, MINCING LANE, LONDON, E.C. 3.

Telephone: Central 11250. Telegrams: Bonlazing—Fen—London

BOILER TUBES.

GAS, WATER & STEAM TUBES & FITTINGS.

MAIN STEAM PIPE INSTALLATIONS.
DESIGNED, MANUFACTURED AND ERECTED.



Sole Licencees in Great Britain for the Manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes.

Write for Descriptive Pamphlet.

THE SCOTTISH TUBE CO., LTD.

Head Office: **34, Robertson Street, GLASGOW.**

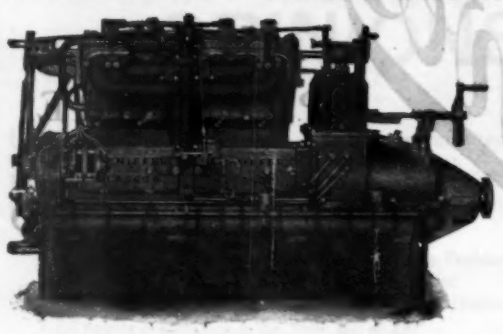
Branch Offices and Warehouses.—London, Manchester, Leeds, Liverpool, Newcastle-on-Tyne, Cardiff; Sydney (N.S.W.); Wellington (N.Z.); Johannesburg, Cape Town and Durban (S.A.).

Works.—Glasgow, Coatbridge, Rutherglen, Garnkirk, Govan.

Telephone—No. 5687 Central (Six lines). Telegraphic Address—Scotubeco, Glasgow.
Codes—A1, A B C (4th and 5th Editions), Lieber's, Western Union and Private

GLENIFFER MARINE MOTORS.

PARAFFIN and PETROL
From 10 to 90 H.P.



Suitable for all types of motor craft, also for stationary purposes such as electric generating sets pumping sets, &c

The illustration shows our latest design 50 B.H.P. Paraffin Engine & Reverse Gear.

GLENIFFER MOTORS LTD., ANNIESLAND, GLASGOW.
Telegrams "GLENGINE, GLASGOW."

MORE SALES?

Certainly it's possible—!
How—? Open New Sources.
In What Line? Any.

In short, we can help you whether a big or little maker of machinery or anything else.

Our method is *Photography* which *appeals* first to the *Eye* and then to the *Brain*.

Don't overburden "prospectives" with specification and type matter, first get interest.

Ask for details of our "Real Photo Publicity."

Success guaranteed.

LILYWHITE LD., HALIFAX.

THE BEST
ELECTRICALLY SMELTED
STEEL CASTINGS
AT COMPETITIVE PRICES.
HIGH TENSILE. DUCTILE.
IDEAL MACHINING QUALITIES.
PROMPT DELIVERY.

T. BALMFORTH & Co. LTD. LUTON.

ONE PRODUCT
ONE QUALITY:
ONE RESULT:
PERFECT SATISFACTION

When you fit Ferodo Friction Linings to your brakes or clutches you have fitted the very best in Fabric Linings.

There is no second quality Ferodo Linings—no second best. Our first principle has always been, and always will be, to put the finest possible materials and workmanship into our products, and on this principle the Ferodo reputation has been built.

The whole of our staff and up-to-date plant is devoted to the production of Ferodo Friction Linings.

We give to our products 100% of our efforts and we claim that they give to the user 100% service.

FERODO
FRICTION LININGS

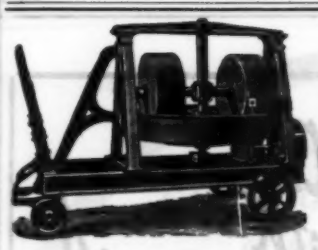
Sole Manufacturers:
FERODO Ld. CHAPEL-EN-LE-FRITH

Depots & Agencies at: London, Birmingham, Manchester, Belfast, Leeds, Bristol, Glasgow, Barnsley, Cardiff, Sheffield, Coventry, Liverpool, Newcastle, Swansea, Carlisle and Brighton. 941

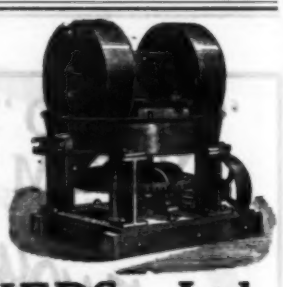
GRAFTON & CO.
CONTRACTORS TO H.M. GOVERNMENT
ATLAS WORKS,
Telegrams: GRAFTON, BEDFORD
BEDFORD.

Illustrated Descriptive List free on application.

SILVER MEDAL, Inventions Exhibition, London, 1885.
GOLD MEDAL, PARIS, 1900.
GRAND PRIX & GOLD MEDAL, Franco-British Exhibition, London, 1908.
GRAND PRIX, Buenos Aires Exhibition, 1910.

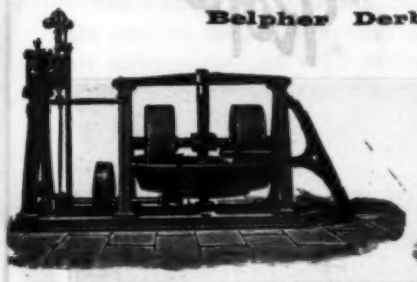


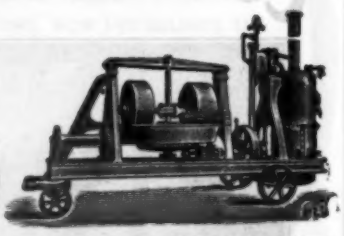
EDGE RUNNER GRINDING MILLS



OF ALL KINDS FOR ALL PURPOSES.

SMEDLEY BROTHERS, Ltd.,
Belper Derbyshire.





SUBMERSIBLE MOTORS, LTD.
'Phone: Southall 12
SOUTHALL, Middx.
Telegrams: Submerse, Southall.

A.C. & D.C. MOTORS, DYNAMOS, ALTERNATORS & MOTOR GENERATORS.

PRICES GREATLY REDUCED.

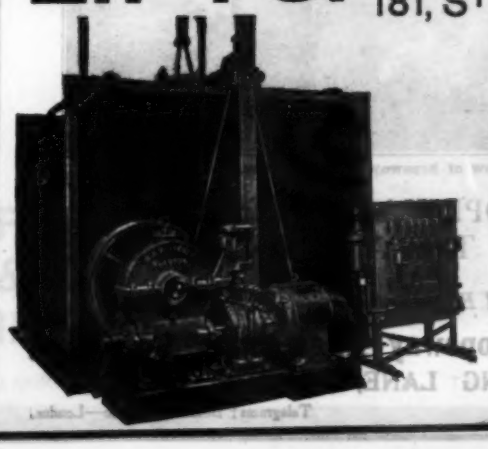
Enclosed Ventilated Ball Bearing Dynamo.

SPECIALITY:
SUBMERSIBLE MOTORS
FOR ALL DUTIES.
In WET & EXPOSED POSITIONS.
PUMPING, etc.

THEY WORK
IN WATER.

COMBINED MOTOR-PUMPS
for all Heads and Outputs.

LIFTS.
A. & P. STEVEN, LTD.,
181, ST. JAMES' RD.,
GLASGOW.

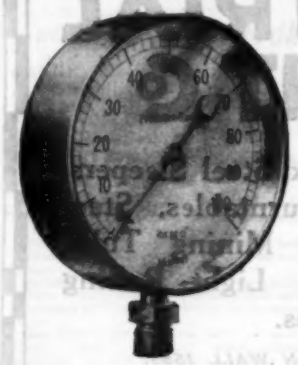


London Office:
10, CHARLES STREET,
BLACKFRIARS, S.E.1.

Manchester Office:
12, CHARLES STREET.

Birmingham:
HARRY ASTBURY, A.M.I.M.E.
DAIMLER HOUSE,
PARADISE STREET.

INDICATING PRESSURE & VACUUM GAUGES



Body is Cast Iron, well varnished, and fitted with brass cover.

Dial is divided concentrically and reading from 0 to 100, 150, 200, 250 and 300 lbs. pressure: also for Vacuum (30in. mercury).

For high quality and value these Gauges cannot be equalled, and are guaranteed to give satisfaction.

Stocked in sizes 4in. and 6in. diameter.

Write us for Prices.

WIRES: COLLOQUIAL, CANNON, LONDON.

J. W. & C. J. PHILLIPS Ltd., 23, College Hill, Cannon Street, LONDON, E.C.4.

PHONE: CENTRAL 10122.

"THE LANCASTER" (R.T.M.) STEAM TRAPS

The SPECIALITY of "THE LANCASTER" STEAM TRAP consists in the loose Disc Valve at the orifice of the discharge pipe in connection with a quick threaded screw motion, worked by the float. This valve is friction-less in action and being loose, cannot stick to its seat. It is very prompt in its movements for opening and closing the discharge pipe, and the working parts are very simple and easily examined. It also acts as a Safety Valve, as any excessive pressure exerted against the face of the loose disc valve would, by virtue of the Quickness of the Screw Thread, force it open.

First Orders "ON APPROVAL."

LANCASTER & TONGE, LTD.

Sole makers of "The Lancaster" Steam Dryers, Pistons, Limit Piston Rings, Metallic Packings, Machine Moulded Wheels, &c.

PENDLETON, MANCHESTER.

Telegrams—"PISTONS, Manchester." Telephone—794 Pendleton.

Northern Machine Screws LIMITED

Telephone: 25600. Leeds Teleg.: VULCAN.

ESTABLISHED 1849.

REDUCE YOUR PAINTING COST

by installing the Aerograph method of painting and varnishing.

The Aerograph distributes the heaviest Enamels, Paints and Varnish far more evenly and rapidly than the old brush method.

Catalogue and Information post free.

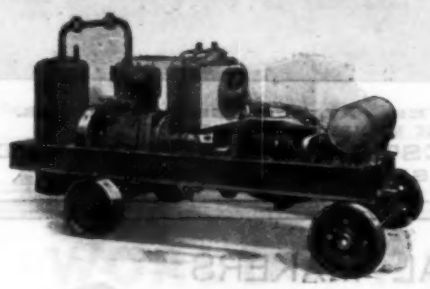
The Aerograph

Regd. Trade Mark.

The AEROGRAPH CO., LTD., *Inventors and Pioneers of the Spray Painting Process.* 43, Holborn Viaduct, LONDON, E.C.1. *British from the First.*

BROOM & WADE, LTD

AIR COMPRESSORS



FIXED, PORTABLE OR STEAM DRIVEN.

Economical in First Cost, Power Cost and Maintenance.

BROOM & WADE, Ltd., HIGH WYCOMBE.

CONTRACTORS TO THE BRITISH GOVERNMENT

Telegrams: "SHIPYARDS, CHEPSTOW." Telephone: CHEPSTOW 77 & 78 (2 lines).

MONMOUTH SHIPBUILDING CO. LTD.

BUILDERS OF ALL CLASSES OF

Merchant and Oil Tank Steamers.

CAISSONS, BARGES & TUGS.

10 BUILDING BERTHS up to 500ft.

Head Office and Works:

CHEPSTOW, MON.

London Office: 77, Gracechurch Street, London, E.C. 3.

Telegrams: "NAMBOURA, BOCK, LONDON." London Telephone: AVENUE 3500.

Here is the "SOLUTION" to your Corrosion Problem!

IT will be found to effectively protect all Iron and Steel-work against corrosion and at less cost than any Lead, Oil or Oxide Paints, which have neither its long life or large covering capacity.

Please send for Samples and Prices.

WILLIAM BRIGGS & SONS, LIMITED

DUNDEE.

BALL & ROLLER BEARINGS

R. & M.

FOR SILENT RUNNING & HEAVY LOADS.

RANSOME & MARLES BEARING CO., LTD.,

NEWARK-ON-TRENT,

TELEGRAMS: "BEARINGS," NEWARK. TELEPHONES: NEWARK 170 & 171.

ENGLAND.

WATER TURBINES.

HIGH GRADE PELTON AND FRANCIS TYPES.

Patent Universal Oil Pressure Governors—delivery from stock or progress.

Hydro-electric Plants. Water power surveyed and reported upon.

SALTERNS, Ltd.,
Water Turbine Manufacturers,
Parkstone, Dorset, England.

CONTRACTORS' PLANT.
CRANES.
PILE DRIVERS.
WHITAKERS (Engineers) LIMITED,
HORSFORTH, LEEDS.

The Steam Cylinder Lubricator Co., Ltd.
Lower Broughton, Manchester.
Sole Makers of
ADAMS AND GRANDISON'S
PATENT SIGHT FEED LUBRICATORS,
also STEAM KETTLES for Canteens, Ships, etc.

STONE AND COAL CRUSHERS ENG.
LEICESTER
GOODWIN BARSBY & Co

HULL FORGE IRON & STEEL Co. Ltd.,
Manufacturers of
BAR IRON and STEEL
in all sections and qualities.
EAST RIDING IRON WORKS, HULL.
London Office: 36, Victoria Street, S.W.

WOOTTON BROS., LTD.,
COALVILLE, near LEICESTER.
Telegrams: Wootton, Coalville.
Brickworks Plant. Sanitary Pipe Plant.
CLAY-WORKING PLANT.
Colliery Plant. General Millwrights.

USE COLLIERY WASTE FUEL
MELDRUM FORCED DRAUGHT FURNACES
Will efficiently consume it and maintain your steam pressure at the lowest cost. Write for list No. 105 F. to us at TIMPERLEY, MANCHESTER.

DAVIE & HORNE, Engineers
Johnstone Engine Works,
Johnstone, near Glasgow.
MAKERS OF
Condensing Plants, Distilling Plants, Evaporators, Feed Water Heaters and Filters, Pumps
Offices . . 45, HOPE STREET, GLASGOW.
Telegraphic Address: Evaporator, Johnstone.
See Illustrated Advert. in issue 15th of December.

HAMWORTHY
PUMPS.
AIR COMPRESSORS. OIL ENGINES
THE HAMWORTHY ENGINEERING Co., Ltd
76, Victoria Street, LONDON.

THOMAS SHANKS & CO.
Johnstone,
FOR
HEAVY MACHINE TOOLS.
SEE HALF-PAGE ADVERTISEMENT IN ISSUE OF DEC. 15th.

STONEBREAKERS,
Crushing Rolls,
Screens, Elevators, and Conveyors.
Complete Plants for Fine Crushing or Macadam are our Specialty.
ROBERT BROADBENT & SON, Ltd.,
Phœnix Ironworks, STALYBRIDGE.
Telephone No. 296. Tel. Address—Broadbent, Stalybridge

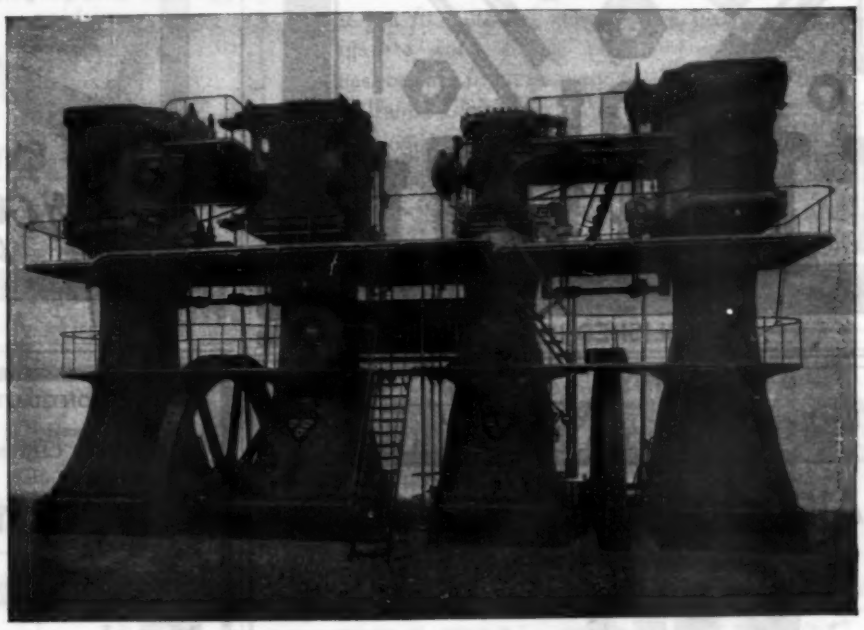
DAVIES & METCALFE,
MANCHESTER. LIMITED
SPECIALITIES:
INJECTORS.
ALL CLASSES.
Illustrated Advertisement every fourth week.

Trade STANLEY Mark.
The Largest Manufacturers of Surveying and Drawing Instruments in the World.
Please send for our "K6" Catalogue.
W. F. STANLEY & CO., Ltd.,
286, High Holborn, London, W.C.

KOPPEL INDUSTRIAL CAR & EQUIPMENT Co

Manufacturers of Portable and Permanent Track, Steel Sleepers, Switches and Turntables, Steel Tipping Wagons, Mining Tubs, Cane Cars, and Light Rolling Stock of all types.

Telephone: LONDON WALL 1585.
London Office
53 NEW BROAD ST.
E.C.2
Telegrams: PENNKOP, LONDON
Head Office & Works: KOPPEL PA., U.S.A.



STEAM BLOWING ENGINES. ALL TYPES AND SIZES.
MANUFACTURED AT THE MIDDLESBROUGH WORKS OF
RICHARDSONS, WESTGARTH & CO., LTD.,
HARTLEPOOL, MIDDLESBROUGH, & SUNDERLAND.

BUY FROM THE ORIGINAL MAKERS
. . OF . .
WELDLESS STEEL TUBES
. . FOR . .
WATER TUBE BOILERS,
LOCOMOTIVE BOILERS
MOTOR AXLES.

W TRADE MARK

SUPERHEATERS,
SHAFTING, BORING RODS,
HYDRAULIC WORK, ETC. ETC.

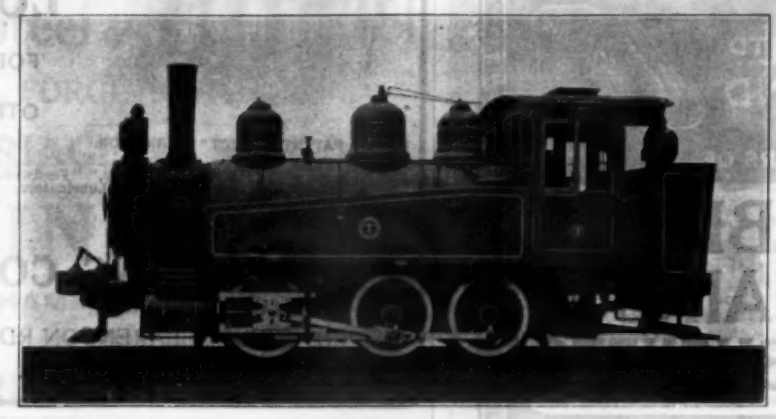
WELDLESS TRADE MARK.

THE WELDLESS STEEL TUBE Co. LTD.
Telegrams:—"WELDLESS, WEDNESFIELD."
Telephone:—1301-1302 Wolverhampton.
WEDNESFIELD, NR. WOLVERHAMPTON.

Baldwin Six-Wheeled Shunting Engine

for Hokkaido Kogyo, Tetsudo, K.K. (JAPAN).

GAUGE: 3ft. 6in.
CYLINDERS: 15in. by 20in.
WORKING PRESSURE: 170 lbs.
FUEL: Soft Coal.
DRIVING WHEELS: Dia., 40in.
WEIGHT: 72,700 lbs.



Low centre of gravity. Can be safely operated over rough and uneven tracks and sharp curves.

Tires are of a specially hard material best adapted for maximum life to both tread and flange.

Springs conveniently placed on short saddles directly over the journal boxes and connected with equalising levers in the same plane.

Bar frames are of extra heavy section. Their "open" character adapt them especially to the convenient placing of equalizing levers and machinery.

Unusually large journals for driving axles and crank pins, insuring maximum life and minimum wear.

Both hand and steam brakes are provided. The Baldwin steam brake is the most efficient yet devised.

Lubrication is by condensing sight feed lubricator in the cab, giving positive and economic operation. This system will be found superior to lubrication by mechanical means. All oil cups on wearing parts are easy of access.

Rocking bar type grates are easy to operate and economical of fuel.

Our interest in these locomotives does not terminate with their completion. They are built to give many years of service, and we are always prepared to furnish promptly duplicate and repair parts to maintain them in first-class condition.

THE BALDWIN LOCOMOTIVE WORKS,

PHILADELPHIA, U.S.A. *Cable Address: "Baldwin, Philadelphia."*

REPRESENTATIVE IN ENGLAND: R. P. C. Sanderson, 31 Victoria Street, London, S.W. 1.

H. J. SKELTON & Co. LD.

ENGINEERS, IRON AND STEEL CONTRACTORS, TO
H.M. GOVERNMENT, PRINCIPAL HOME, FOREIGN AND COLONIAL RAILWAYS.
ON ADMIRALTY, WAR OFFICE AND INDIA OFFICE LISTS.

STEEL

Ingots, Blooms, Billets, Slabs, Forgings, Sections, Loco Frame Plates,
Ship, Tank, Bridge and Boiler Plates, etc. etc.

Black, Tinned, or Lead Coated, Galvanized, Corrugated or Flat Sheets to 30 B.W.G.

PIG IRON, WROT IRON, ALLOY STEEL,
RAILS AND FASTENINGS.

ROYAL LONDON HOUSE, FINSBURY SQUARE, LONDON, E.C.2

Telegrams: "HISKELTON, FINSQUARE, LONDON." Telephone: CLERKENWELL 3027-8-9 (3 lines).

WORLD - RENOWNED
— FOR —
STRENGTH AND DURABILITY.

DORMER BRAND.

DORMER BRAND.

HIGH SPEED TWIST DRILLS & REAMERS.

MILLING CUTTERS, TAPS & DIES, SAWS, FILES, COTTER PINS.

SHEFFIELD TWIST DRILL & STEEL Co LTD

Telephones 712 SHEFFIELD. 2660 CITY, LONDON. *Telegrams* "PROELLS" SHEFFIELD.

ON ADMIRALTY LISTS.

John Kirkaldy

London Office:
101, Leadenhall Street, LONDON E.C. 3.
Works: Burnt Mill, near Harlow, Essex.
Makers of
Evaporating and Distilling Plants.
Refrigerating & Ice Making Machinery.
Feed Water Heaters. Feed Water Filters.
Fresh Water Distillers. Evaporators.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers, &c. &c.

Werf GUSTO, Firma A. F. Smulders,

SCHIEDAM, HOLLAND.
SPECIALITIES -
DREDGING PLANT, FLOATING CRANES AND COALING VESSELS.
See our page Advt. every second and fourth week.

GRAIN, CHILL & STEEL **ROLLS.**
HEAVY **CASTINGS** Iron upto 100 tons. Steel up to 40 tons.
Cast Steel Locos. Wheel Centres a Speciality.
R. B. TENNENT, LIMITED.
COATBRIDGE, N.B.

JOHN ROGERSON & CO., LTD.,

WOLSINGHAM, R.S.O., Co. DURHAM.
Makers of
Steel Castings and Steel Forgings.
Stockless Anchors, Dredger Buckets, Links, and Tumblers, Steering Gear &c. &c.
SEND YOUR ENQUIRIES.
Telegrams: Steelworks, Wolsingham.

GEAR CUTTING.

Spur and Bevel.

Rogers McGown & Co., 4, Livesey Rd., Manchester.

A. BEEBEE,

Bolts, Nuts, Studs, &c.
WEDNESBURY.

THE
MACFARLANE ENGINEERING CO.
LTD.,
NETHERLEE ROAD, CATHCART.
DYNAMOS & MOTORS.

See advertisement in issues of Dec. 8th and Jan. 5th.

GOODALL CLAYTON & Co LTD
LEEDS
CONVEYING PLANTS, BUNKERS &c

CAST IRON & G.M. COCKS
For GAS, STEAM & WATER.

BRITISH STEAM SPECIALTIES
Wharf Street, LEICESTER. Ltd.

MORRIS
RUNWAYS AND PULLEY BLOCKS

CHUCKS
MANUFACTURED BY
F. PRATT & CO., LTD.
HALIFAX, ENGLAND.
See Illustrated Advertisement, Dec. 8th, Page 82.

LOUDON BROTHERS, LTD.,
JOHNSTONE.
Makers of Highest Class Machine Tools.

See illustrated advertisement in issue of December 1.

MALLEABLE IRON DETACHABLE DRIVE CHAINS

EWART CHAINBELT Co LTD DERBY. ENGLAND.

ORIGINAL BRITISH MAKERS OF

DETACHABLE DRIVE CHAINS & ELEVATOR BUCKETS

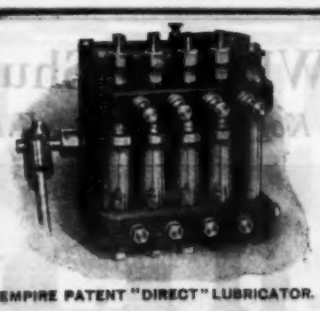
THE ABOVE ARE MADE OF LEY'S CELEBRATED "BLACKHEART" MALLEABLE IRON

GOVERNING DIRECTOR
MAJOR SIR GORDON LEY BART
DIRECTORS
E. N. WOOD W. H. ATHERTON
I. F. PANTON.

MALLEABLE IRON DETACHABLE DRIVE CHAINS

MALLEABLE IRON DETACHABLE DRIVE CHAINS

MALLEABLE IRON DETACHABLE DRIVE CHAINS



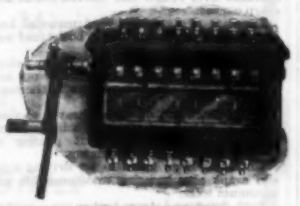
EMPIRE PATENT "DIRECT" LUBRICATOR.

"EMPIRE" FORCE-FEED **LUBRICATORS** FOR **DIESEL** AND OTHER **ENGINES**

MADE IN ANY NUMBER OF FEEDS.

Also makers of the "Victor," "Trusty," "Feedwell," "Surefeed," and other Force-Feed Lubricators.

EMPIRE ENGINEERING CO. (MANCHESTER) LTD.
EMPIRE WORKS, CLARENDON RD., Salford, MANCHESTER.

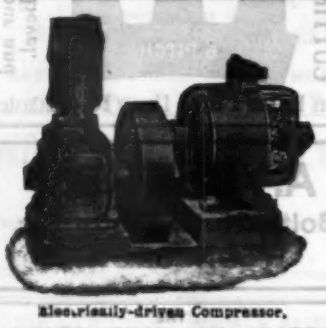


EMPIRE PATENT "TWIN-PLUNGER" LUBRICATOR.

Condenser, Awarded —GOLD MEDAL— At Franco-British Exhibition, 1908.

KORTING BROS. (1917) LTD.
27, SHAFTESBURY AVENUE, W.1.

Multijet Ejector Condensers for High Vacua.
Water Cooling Plants.
Universal Injectors.
Steamjet Elevators and Silent Water Heaters.
Gasproducer Blowers and all Steamjet and Waterjet Apparatus.
Gilled Pipes and Complete Heating Plants.
Spray-Nozzles.



Electrically-driven Compressor.

Air Compressors
Capacities from 1 c. ft. to 300 c. ft. free air per minute. BELT, STEAM, ELECTRIC and OIL DRIVE.
Vacuum Pumps.
DIVING APPARATUS of all patterns
OXYGEN BREATHING APPARATUS for work in poisonous air.
Smoke Helmets.
Medical Oxygen Apparatus
IMMEDIATE DELIVERY.

SIEBE, GORMAN AND CO. LTD.,
"NEPTUNE" WORKS and 187, WESTMINSTER BRIDGE ROAD, LONDON, S.E.
Telegrams: "Siebe, Lamb, London." Cables: "Siebe, London." Telephone No.: Hop 3401/2 lines

Boving Engineering Works, Ltd.,
General Engineers and Ironfounders.

Tube Mills
Bunkers
Chimneys
Conveyors
Elevators
Castings

Tanks
Hoppers
Points and Crossings
Turntables
Buoys

Tel.: "BOVING," STOKE-ON-TRENT.
'Phone: 263 Central.

LONDON OFFICE: 56, Kingsway, LONDON, W.C. 2.

STOKE-ON-TRENT.

The Belt Built for Better Driving

Hendrys' *Laminated* BELTING

THE ingenious construction of HENDRYS' BELTING gives an unequalled flexibility and entirely obviates slipping or vibration. A HENDRY BELT will give a satisfactory drive over the smallest of pulleys when all other belts have failed.

Write for Booklet.

Sole Makers and Patentees:
JAMES HENDRY, LTD.,
Laminated Leather Works,
BRIDGETON, GLASGOW.

LEROY'S COMPOSITION,
For Coating Boilers, Steam Pipes, &c.
Prevents the radiation of heat, saves fuel, and increases the power of steam.
In London the cost of the covering is saved in about six months.
On Admiralty and War Office Lists.
Three boilers covered with this Composition will do the work of four not covered, May be seen where it has been in use for twenty years.
Established 1865.
F. LEROY & CO, 10, Gray Street, Commercial Road, London, E.1.
Also at Manchester.

GEO. ADLAM & SONS, LTD.,
FISHPONDS FOUNDRY,
BRISTOL.

ANY DESCRIPTION. 1lb. TO 10 TONS EACH.

QUICK DELIVERY GUARANTEED.

IRON CASTINGS

ALSO
BRASSFOUNDERS AND COPPERSMITHS.

THOMAS TURTON & SONS
LIMITED.

MANUFACTURERS OF

Crucible Cast Steel & Spring Steel

STEEL FORGINGS,

ENGINE, CARRIAGE & WAGON

SPRINGS.

CAST STEEL FILES & HAMMERS FOR ENGINEERS

SHEAF WORKS, SHEFFIELD.

London Office: NORFOLK HOUSE, 7, LAURENCE POUNTNEY HILL, E.C. 4.

THE STEEL COMPANY OF SCOTLAND LTD

SIEMENS PROCESS

EST'D 1872. "HALLSIDE"

23, ROYAL EXCHANGE SQUARE, GLASGOW.

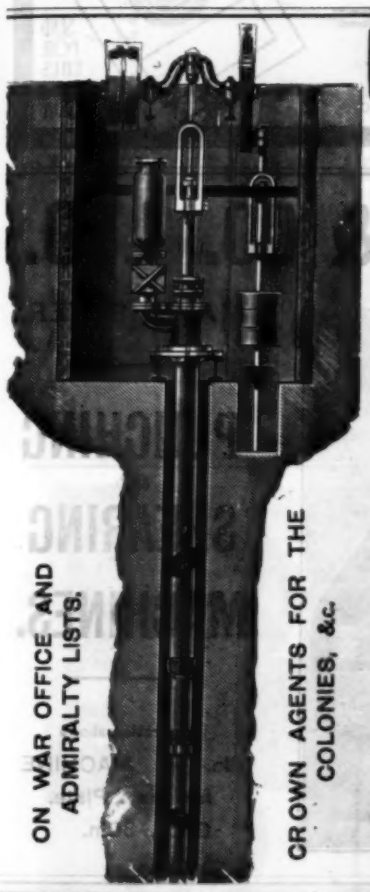
WORKS: HALLSIDE, NEWTON, and BLOCHAIRN, GLASGOW.

OFFICES: 23, ROYAL EXCHANGE SQUARE, GLASGOW, and 9, MINCING LANE, LONDON.

CONTRACTORS TO BRITISH ADMIRALTY, AIR DEPARTMENT & FOREIGN & COLONIAL GOVERNMENTS

Manufacturers of

MILD STEEL Plates for Ships, Boiler and Bridge-building, Angles, Zed Bars, Tees, and all forms of Sectional Bars required for constructive purposes.
CASTINGS of all kinds and largest sizes for Ship Stems, Stern Posts, Anchors, Rudders, &c.
FORGINGS of every description.
AXLES of highest quality, to meet requirements of Home and Colonial Railways.
TYRES—Locomotive Carriage and Wagon, to all requirements.
SPECIAL STEEL of all kinds used for constructive purposes.



ON WAR OFFICE AND ADMIRALTY LISTS.

CROWN AGENTS FOR THE COLONIES, &c.

BOREHOLE PUMP.

WATER SUPPLIES
FROM
ARTESIAN WELLS

For City Offices, Hotels, Laundries, Gentlemen's Private Houses and Estates, Tanneries, Nurseries, Breweries, &c. &c.

WELL BORING TOOLS & TUBES

For Testing Ground, Prospecting for Minerals, Trial Holes from 30ft. to 1000ft.

EXPORT TRADE TO ALL PARTS OF THE WORLD.

DEEP WELL PUMPS.

Complete Boring Plants and Pumping Plants Let on Hire.

CONTRACTORS' & DIAPHRAGM PUMPS.

R. RICHARDS and CO.
Upper Ground Street,
LONDON.

ESTABLISHED 1865.

RELIANCE

Sheet Metal Working Machinery and Dies for every purpose.

Most advanced designs on the market.
Every machine built to give Maximum Service.

Illustration shews No. 18 Inclinable Press.
—Other sizes manufactured.

SPECIAL FEATURES INCLUDE:—
1.—New Design Crankshaft Bearings having joints at right angles to line of pressure and wedge adjustment to bottom steps.
2.—Patent Safety Clutch which is the simplest and most efficient in use.
3.—Patent Spring Engagement Device for Clutch.

Full particulars upon application to—
Fieldhouse, Crossfield & Co., Ltd.,
Wharfedale Foundry - - OTLEY.
Send us your Press Problems.
Telephone 116 Telegrams: RELIANCE

HIGH GRADE WIRE ROPES

for Engineering.

W. B. BROWN & Co.
(BANKHALL), Ltd.,
GLOBE WORKS,
LIVERPOOL.

Stern Wheel Steamers,
Ocean Cable Steamers,
Gold Dredgers.

Bucket and Suction Dredgers of all sizes

LOBNITZ & CO., LTD.
Engineers & Shipbuilders,
RENFREW, SCOTLAND.

Telegrams: "LOBNITZ, RENFREW."

Sole Makers of Patent Rockbreaker
for rock excavation under water without explosives.

Registered Trade Mark—"BUCYRUS."

BUCYRUS 30-B UNIVERSAL SHOVEL.

STEAM, ELECTRIC, OR PETROL DRIVEN.

The last word in Shovel Construction.

By addition of a few extra parts, this shovel can be used as a Dragline Excavator, Clam Shell Excavator, Trench Excavator, Crane or Pile Driver. It can be mounted on Caterpillar Traction, Road Wheels or Railway Wheels.

London Office:
Hildebrand House, Caxton Street S.W.1

BUCYRUS COMPANY, Head Office, South Milwaukee, Wisconsin, U.S.A.

Kelvin Engines

Standard arrangements of Stationary Engines covering all requirements

With or without Radiator Cooling
3 to 60 H.P. on Paraffin or Petrol

For AIR COMPRESSORS, DYNAMOS, PUMPS, HOISTS, and all jobs requiring a power unit of absolute dependability.

Write for Engine Catalogue No. 6.

The Bergius Launch and Engine Co., Ltd.,
254, Dobbies Loan, GLASGOW.

STRUCTURAL STEELWORK

BRIDGES, PIERS, VIADUCTS,
ROOFS, CRANES, STEEL and C.I.
TANKS, GASWORKS PLANT,
PRESSED STEEL FLOORING,
RIVETED STEEL PIPES,
—— ETC. ——

— CALNE VIADUCT. G.W.Ry. 175ft. SPAN. —

Head Offices & Works:
TIPTON, STAFFORDSHIRE.

London Office:
11, VICTORIA STREET, S.W.

Telegrams:
HORSELEY, TIPTON.
Telephone: 107 TIPTON.

THE . . .
HORSELEY BRIDGE & ENGINEERING Co. Ld.

SMOOTH-ON
TRADE-MARK

BEWARE OF IMITATIONS.

IRON CEMENTS

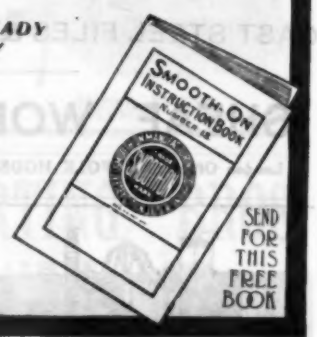
Make permanent repairs of steam, water, or oil leaks on iron and steel castings, boilers, engines, tanks, etc.

Every engineer and foundryman should have a copy of our new 144 page illustrated instruction book. It is free.

LARGE STOCKS ON HAND READY FOR IMMEDIATE DELIVERY

LONDON.
Messrs. F. A. Fullen & Co., 86, Harleyford Road, Vauxhall, S.E.11
Beck & Hickman, Ltd., 24 Whitechapel Road, E.
LIVERPOOL.
Mr. John Taylor, 10, Strand Street
MANCHESTER.
A. Dawes & Sons, Ltd., 131, London Road
Fred T. Hilton, 94, Hardman St., Deansgate
Thomas E. Whitworth, Ltd., Denton, Nr. Manchester.
CARDIFF.
A. E. Smithson & Co., West Bute Street.
GLASGOW.
Andrew McLean & Co., 100 Main St., Bridgeton
SHEFFIELD.
Dewhurst's Engring Co., Ltd., Attercliffe Road.
BIRMINGHAM.
Messrs. Clark and Howard, 177, Corporation Street.

Sole Representatives—
WALTER P. NOTCUTT, LTD.,
8, White Street, Moorfields, LONDON, E.C.



DE BERGUE & CO., LTD.,
MANCHESTER.

PUNCHING AND SHEARING MACHINES.

Illustration shows
No. 4c MACHINE
for 1in. Plate.
Gaps, 30in.

FLETCHER MALLEABLE FOUNDRIES LTD.

Telegrams—"Foundries, Derby." DERBY. Telephone—881 Derby.

ELEVATORS & CONVEYORS
for
GRAIN,
COAL,
ASH, etc. etc.

CHAINS,
Ewart's Type
Gray's Style and
Bushed.

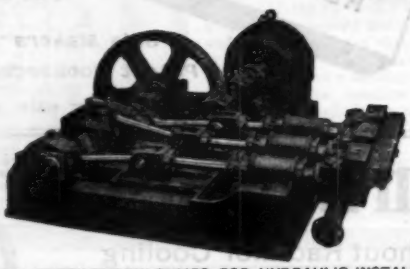
WHEELS,
Sprocket and
Traction in
Cast Iron & Steel.

BUCKETS,
Malleable Iron,
Seamless and
Riveted Steel.

HIGH GRADE
MALLEABLE
CASTINGS.

DAVY BROS. LTD
SHEFFIELD.

ENGINEERS AND BOILERMAKERS

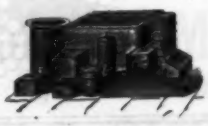


HORIZONTAL THREE-THROW PUMPS FOR HYDRAULIC INSTALLATIONS.

HIGH-CLASS CONSTRUCTION FOR HEAVY DUTY.
FORGED STEEL PUMP AND VALVE BOXES. IMPROVED CAGE-SEAT VALVES.
ENCLOSED CUT DOUBLE-HELICAL GEAR.

HIGH-SPEED FORGING PRESSES.
ROLLING MILLS AND STEEL WORKS MACHINERY. Q573

ICE TANKS
a speciality.
Prepare for the
SEASON.
Write for our price lists and state your requirements.



W. P. BUTTERFIELD LTD.
SHIPLEY,
YORKS, ENGLAND.
'Grams: "Tanks Shipley." Phones: 86 & 585 Shipley.
M.H.

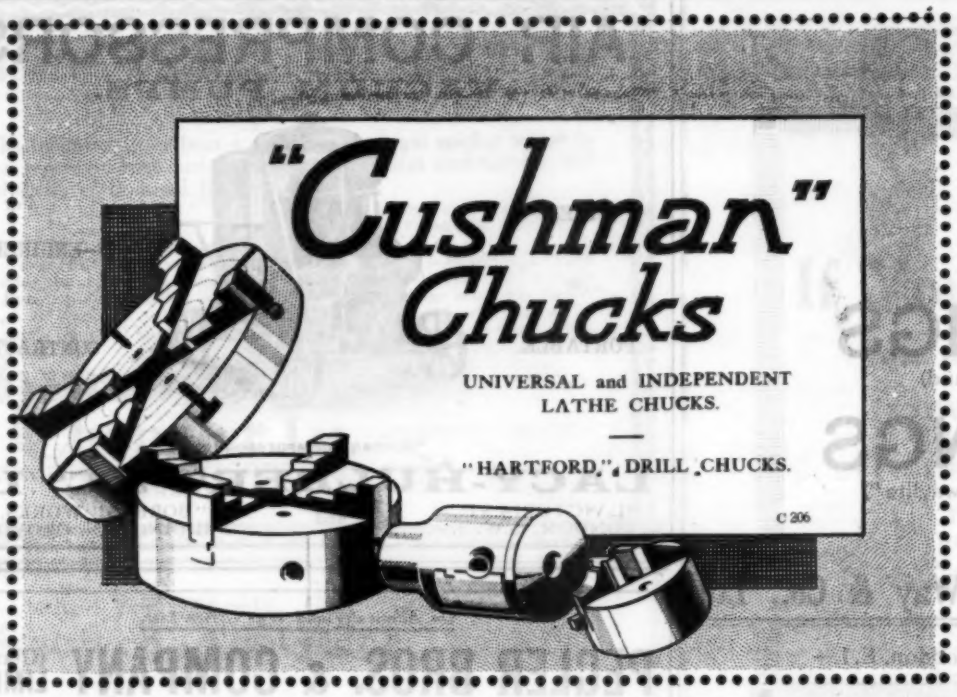
DYSON'S DIE CASTINGS
SAND CASTINGS IN ALL NON-FERROUS METALS AND ALLOYS.
DIE CASTING MACHINES AND COMPLETE EQUIPMENT
DYSON & CO. ENFIELD (1919) LTD., SOUTHBURY WORKS, PONDERS END, MIDDX.

BRIDGES — ROOFS.
ALEXR. FINDLAY & COY. LTD
Structural Engineers, MOTHERWELL, Scotland.

SPECIALITY:
STAMPED STEEL
FLOOR TROUGHING.

A B C CODE
4th & 5th
EDITIONS.

Head Office: MOTHERWELL.
London Office: 9, VICTORIA ST. S.W.
Telegrams {"Findlay, Motherwell." "Parkroad, London."}



"Cushman" Chucks

UNIVERSAL and INDEPENDENT LATHE CHUCKS.

"HARTFORD," DRILL CHUCKS.

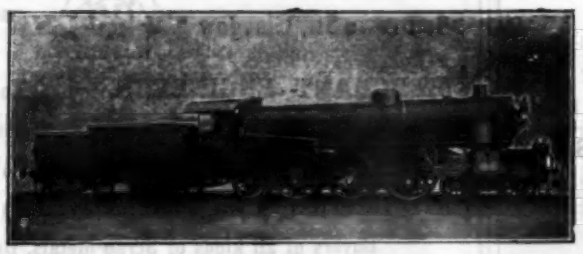
C 206

SOCIETA ITALIANA ERNESTO BREDA, per Costruzioni Meccaniche, MILANO (Italy).

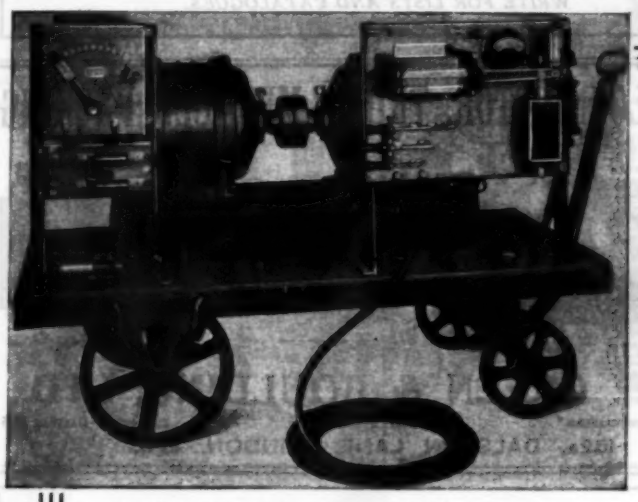
Old Established Firm.

6500 OPERATIVES.

Share Capital, lt. £100,000,000



Steam and Electric Locomotives
Railway and Tramway Rolling Stock.
Portable and Thrashing Engines.
Road Rollers, &c. &c.



A Mobile Welding Unit—

The Wilson Plastic-Arc Welding System has thoroughly proved its high efficiency in operation by a large number of users of the most various requirements, in all parts of the world. On the left is shown a Portable Outfit.

Portable unit, one-arc, Motor Generator type, Plastic-Arc-Welder.

Post a card to-day for full details

G. D. Peters & Co. Ltd.

Caxton House, Westminster, London, S.W. 1.

Telephone: Victoria 2900 and 2901. Works: SLOUGH AND SUNBURY. Telegrams: "Peters, Vic., London."

LOCOMOTIVES.

MANNING, WARDLE & CO., LTD.

BOYNE ENGINE WORKS, LEEDS.

Makers of Locomotive Engines for any width of gauge and various purposes. Also makers of Internal Combustion (Petrol) Locomotives. Materials and workmanship of the best quality. Tank Engines up to 18in. cylinders, on four or six wheels, always in stock or in progress. Specifications, Photos and Prices on Application, and special designs sent on receipt of particulars of requirements.

LONDON OFFICE: Mr. H. J. Heagerty, 34, Victoria Street, Westminster, S.W. 1.

SEE'S ASH EJECTOR

OVER 3500 IN USE.

SOLE PROPRIETORS & PATENTEES: TYNE

F. J. TREWENT & PROCTOR, Ltd.,

Naval Architects and Consulting Engineers,

43, Billiter Buildings, Billiter Street, LONDON, E.C.

Telegrams: Trewent, London 'Phone: 121 Avenue

HUDSON Patent Sectional Water Tube BOILER

THOMAS HUDSON, LTD. COATBRIDGE

THE ROBSON GAS and OIL ENGINES PRODUCER GAS PLANTS.

SOLE MAKERS:

JOHN ROBSON (Shipley) LTD., SHIPLEY, YORKS

See illustrated advt. last and next week's issues.

STEVENSONS, PRESTON.

IRON AND STEEL CASTING LADLES

STEAM ENGINES, MILL GEARING, &c.

S. S. STOTT & Co. *Engineers*, HASLINGDEN.

A STEP IN THE RIGHT DIRECTION TO TRADE REVIVAL.

GET A WEIGHING MACHINE

Made by

Saml. Denison & Son, Ltd., Parkside, Leeds.

EAST FERRY ROAD ENGINEERING WORKS CO. LTD.,

MILLWALL, LONDON, E.,

Hydraulic & General Engineers & Ironfounders

See our illustrated advert. in last and next week's issues.

Telegrams Hydrostatic, London.

SUPERHEATERS FOR ALL TYPES OF BOILERS.

T. SUGDEN, LTD.,

180, Fleet Street, London, E.C. 4

See Advt.—"Engineer"—Dec. 22.

Cling-Surface

THE DAYS OF TIGHT BELTS ARE OVER.

enables belts to run slack on all loads without slip.

THOMAS & BISHOP, Ltd., 37 Tabernacle St., E.C. 2.

The COIL CLUTCH CO., Ltd.,

Phœnix Works, Johnstone, Scotland.

Manufacturers of

COIL FRICTION CLUTCHES

For all Purposes, Powers and Speeds.

Quotations and Designs supplied on receiving particulars of application.

See Illustrated Advertisement last week & next

THE CONSOLIDATED BRAKE & ENGINEERING COMPANY, Limited,

CAXTON HOUSE, TOTHILL ST., WESTMINSTER, S.W. 1

Manufacturers of the

Standard Automatic Vacuum Brake

and

Rapid Acting Service & Emergency Accelerator

See Illustrated Advertisement last week and next.

Tels.: Peters, Vic., London. Telephone No. 2900-1 Victoria

SCALING BOILERS

THERE IS NOTHING SO QUICK & EFFICIENT AS THE "Skatoskale" PNEU. SCALING TOOL

SEE MY ADVERT IN ISSUE OF Dec. 22nd.

FRANK GILMAN 51, WILDERS DRIVE, WARWICK ROAD BIRMINGHAM

ASBESTOS

FIBRES
PACKINGS
("Achilles" Brand)
JOINTINGS
("Durite" and "Hobwaylite")

Hobdell, Way & Co., Ltd.

—45, Church St., Minories, London, E.1.—

Telegrams:—"Hobnails, Ald. London." 'Phone:—Avenue 3810.

AIR COMPRESSORS
VACUUM PUMPS.

FIXED or PORTABLE.

"BOREAS" COMPRESSOR UNIT.

For ENGINEERS and CONTRACTORS.

LACY-HULBERT & Co. LTD.

91, VICTORIA ST., LONDON, S.W. 1. and "BOREAS" WORKS, BEDDINGTON, CROYDON.

On Admiralty and War Office List.

PEGLER BROS. & COMPANY (Glasgow) LIMITED.

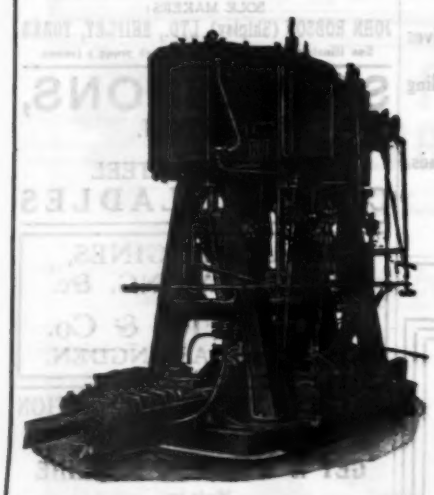
Telegrams—Gunmetal. Telephone—3240 Central.

Registered Office—
54, Brown St., Glasgow

REGISTERED TRADE MARK

Works—
Bridgeton Smelting Works
Fordneuk St. Glasgow.

MERCHANT ENGINEERS. Tools and Sundry Material.
BRASS FOUNDERS. Steam and Water Fittings.
METAL ALLOYERS. Gun, Bush, Yellow, Brazing Metal Ingots.
ANTI-FRICTION METAL MAKERS. Admiralty and other Specifications
Buyers of all kinds of Scrap Metals, Brass Borings, etc.
WRITE FOR LISTS AND CATALOGUES.



W. SISSON & Co. LTD.

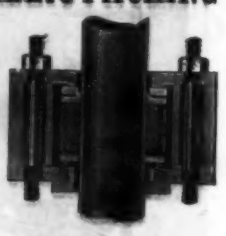
ENGINEERS,
GLOUCESTER,
England.

Tels.: "Sisson, Gloucester."
Cables: Sisson, Gloucester, Eng.
Tel. No. 57. Code A.B.C. 5th Ed.

MAKERS OF
HIGH SPEED ENCLOSED & MARINE STEAM ENGINES.

BUFFALO INJECTOR. TRIPP'S METALLIC PACKING

Illustrated Catalogue with prices and full particulars of both classes of Injector and Metallic Packing on application.



GREEN & BOULDING, LTD.,

Telegrams—"Thermatear." Engineers. Telephone—Dalston 1033

182a, DALSTON LANE, LONDON, E. 8.

DODGE WOOD SPLIT PULLEYS

PERFECTION OF STRENGTH BALANCE AND FACE GRIP

ALL SIZES
FIVE INCHES TO FIVE FEET

GANDY BELT MFG Co LTD SEACOMBE CHESHIRE

OXYGEN FOR THE CUTTING & WELDING OF METALS.

If you wish to hear of the latest improvements in the use of Oxygen for Cutting and the Oxy-Acetylene Welding Process, write to the British Oxygen Company.

THE BRITISH OXYGEN COMPANY have highly equipped and up-to-date factories in all the important British industrial centres, capable of producing

ABOUT 3,000,000 CUBIC FEET OF OXYGEN DAILY.

The Company are the foremost manufacturers in Great Britain of Oxygen Metal-Cutting Apparatus, Oxy-Acetylene, Oxy-Hydrogen and Oxy-Coal-Gas Welding Blow-pipes, High Pressure Gas Regulators, etc.

For Catalogues and full particulars apply to any of the Company's Works:—

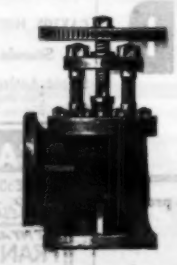
Angel Road, Upper Edmonton, London, N. 18.
North Wembley, Middlesex.
Tunnel Avenue, East Greenwich.
Shields Road, Walker Gate, Newcastle.
Lower Walsall Street, Wolverhampton.
Lodge Road, Hockley, Birmingham.
Knowsley Road, Bootle.
Derry Road, Coventry.
Great Marlborough Street, Manchester.
Rosehill, Polmadie, Glasgow.
East Moors, Cardiff.
Savile Street, Sheffield.
Bromborough Port, Near Birkenhead.
Saville Green, Leeds.

THE BRITISH OXYGEN CO. Ltd.,
ANGEL ROAD, UPPER EDMONTON, LONDON, N. 18.

A. COCKBURN & CO.,

THISTLE VALVE WORKS,
GATESIDE ST., GLASGOW.

SPRING SAFETY VALVES.
STOP VALVES FOR MARINE BOILERS.



STEAM VALVES FOR PIPING.
DISTRIBUTION VALVE CHESTS.

Phosphor Bronze, Gunmetal & Brass Castings.

HIGH-CLASS STEAM FITTINGS.
Speciality—SHIPS' DECK FITTINGS.

JOHN McROBIE & SONS, 91, ELLIOT STREET, GLASGOW
On Admiralty List. Telephone—CENTRAL 1741

North-East Coast Representative:
CHAS. RUTHERFORD,
North Eastern Gas Chambers,
MIDDLESBROUGH.

METERS for Water, Steam, Compressed Air, & Gas.

GEORGE KENT LTD., 199, High Holborn, LONDON, W.C. 1.

Specify BUMSTED ENGINES for Reliable Service.

The following letter from a satisfied user is yet another tribute to the superior design and construction, first-class workmanship, and reliability of Bumsted Engines:—

Borough of St. Pancras, Dept. of Works,
Town Hall, Pancras Rd., N.W. 1.

Messrs. Bumsted & Chandler, Ltd., Hednesford, Staffs.

Dear Sirs,—Further to your letter of 27th ulto., I am glad to be able to inform you that the new engine has been satisfactorily working for the past week, and I trust this engine will give as satisfactory service as the old engine it replaces, which was supplied about 28 years ago, and has been working practically three shifts per day at this Council's Destructor Works, running the forced draught, mortar mill and stone breaker.

Yours faithfully,
(Sgd.) E. W. SWINSTEAD,
Borough Engineer & Surveyor.

Bumsted and Chandler Ltd.
HEDNESFORD STAFFORDSHIRE
ESTABLISHED 1873.

ENQUIRIES INVITED.
Telephone: Cannock 46.
Telegrams: Bags, Hednesford.

A little set that will save you costly stoppages

If Your Motors Spark you are risking breakdown

HOWEVER clean your Works, dust WILL collect in electrical gear and damage the insulation.

This little set will blow the dust away. It delivers a high pressure jet of DRY AIR, is readily portable and can be run off any lamp socket.

If you wish to protect your motors and other electrical gear send for leaflet No. "E.1480" illustrating and describing these sets.

STURTEVANT ENGINEERING Co. Ltd.
149 Queen Victoria St., London E.C.4

Why You Should Use
Dissolved Acetylene for Cutting.

IN cutting metal, it is speed which counts. The quicker the work is done, the less the cost. In all oxy-acetylene cutting operations pre-heating is necessary. This is effected more rapidly by Dissolved Acetylene, which, in addition, performs the actual work more quickly than any other medium. The gas is always ready for use, to begin work at a moment's notice. The plant is easily portable so that it can be taken to the job in hand and started without any delay whatever.

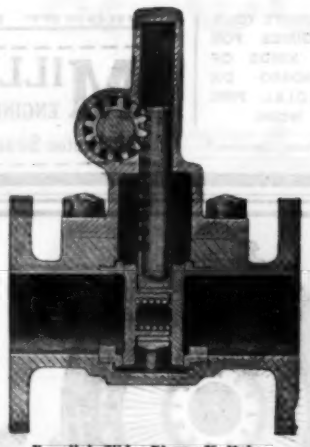
Apply for full particulars:—

Allen-Liversidge Ltd.
Head Office: 106, Victoria Street, S.W.1.
Telephone: Victoria 4155 (Pte.Exch. Exchange)
Telegrams: "Acetylator, Sowest, London."

MICA
F. WIGGINS & SONS.
Telephone: Avenue 2242.
FOR INSULATION, FURNACE SIGHT-HOLES, etc.
Largest Stock in the World.
102, 103, and 104, Minories, LONDON.

VALVES
— AND —
BOILER MOUNTINGS

MAKERS OF ALL KINDS OF VALVES AND BOILER MOUNTINGS.



Parallel Slide Blow-off Valve.

UNEQUALLED FOR SIMPLICITY, RELIABILITY, EFFICIENCY.

APPROVED BY HOME AND FOREIGN GOVERNMENTS, BOARD OF TRADE, LLOYDS, AND INSURANCE COMPANIES

ALWAYS SPECIFY
TURNBULLS
ALEX. TURNBULL & CO., Ld., BISHOPBRIGGS, GLASGOW.
Telephone—49 and 50 Bishopbriggs. Telegrams—Valve, Glasgow.

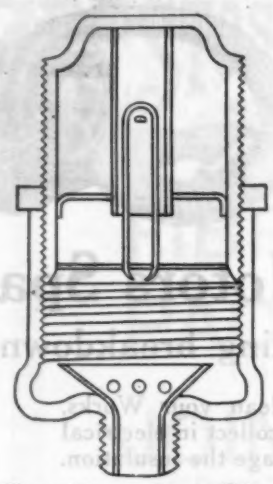
"ANDERSON" ELECTRIC OVERHEAD TRAVELLING CRANES

Electric Overhead Travelling Cranes are our speciality, and every one we build is designed especially for the conditions under which it will operate.

Speeds are chosen to suit the work in hand, and all motions can be controlled from the cage or floor; whichever is desired.

We do all our own structional work, and use only electrical equipment of the highest repute. We guarantee 25 per cent. overload capacity with each crane supplied, and on hearing your requirements, will submit estimate and specification.

THE ANDERSON-GRICE Co LTD
TAYMOUTH ENGINEERING WORKS - CARNOUSTIE - SCOTLAND



Section 1oz Size.

THE "MENNO" GREASE CUP.

Pressed from heavy gauge Brass and Steel, for general use.

Made in six sizes, from ½in. to 2½in. diameter.

We court the fullest investigation and will supply Cups and Grease for trial. RETURN the Cups if not satisfactory.

Little attention required; continuity of feed extends over long periods.

A possible saving of 75 per cent. in Lubrication costs.

THE "MENNO" COMPRESSED AIR GREASECUP CO., LTD.,

LEEDS PLACE, TOLLINGTON PARK, LONDON, N. 4.

BOLLING & LOWE, LTD.,

Engineers and Merchants

(Formerly Wm. Bird & Co. Established 1827.)

LONDON, E.C. 4.
2, LAURENCE POUNTNEY HILL.

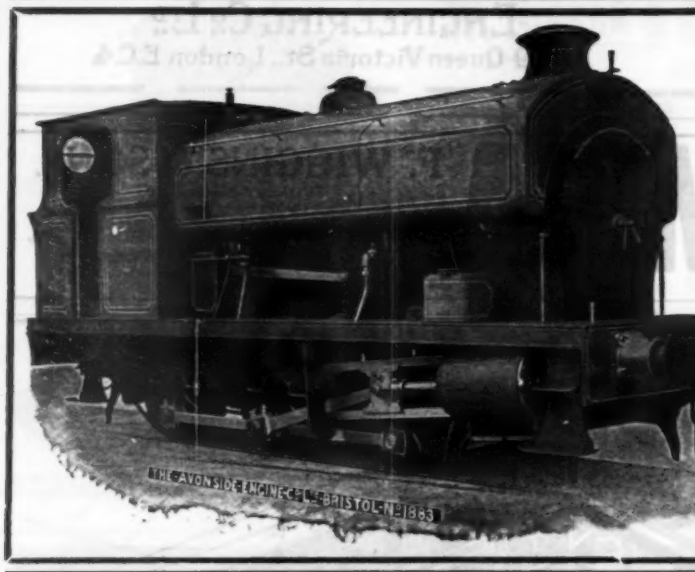
Telegrams: BIRD, CANNON, LONDON. Telephone: City 9396, 9397.
Codes Used: A B C, A1, Engineering Telegraph, Liebers and Western Union.

Contractors to the Admiralty, War Office, Crown Agents for the Colonies, &c. Agents for Foreign Governments.

PLANS AND ESTIMATES for Every Description o.

Machinery, Tools, Railway & Tramway Materials, Portable Railway, Mining & Contractors' Plant.

STOCKS OF NEW AND SLIGHTLY DEFECTIVE RAILS.

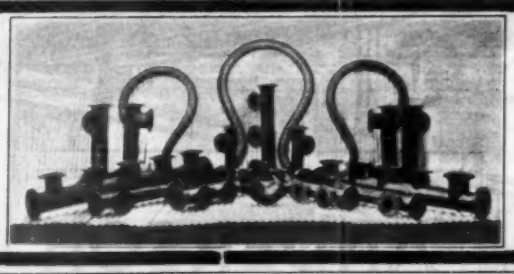


AVONSIDE

ENGINE Co., LTD., BRISTOL.

LOCOMOTIVES

IN STOCK AND PROGRESS.



"MILLWALL PRODUCTS"

STEEL PIPE AND COILWORK IN ALL SIZES.

WE INVITE YOUR ENQUIRIES FOR ALL KINDS OF STANDARD OR SPECIAL PIPE WORK.

Phone: Gerrard 1327. Telegrams: "Ironware, Piccy, London."

PROMPT DELIVERY!

MILLWALL ENGINEERING CO. Ltd.,
21, Panton Street, London, S.W.1.

LLEWELLINS' MACHINE Co.
BRISTOL.

Makers of

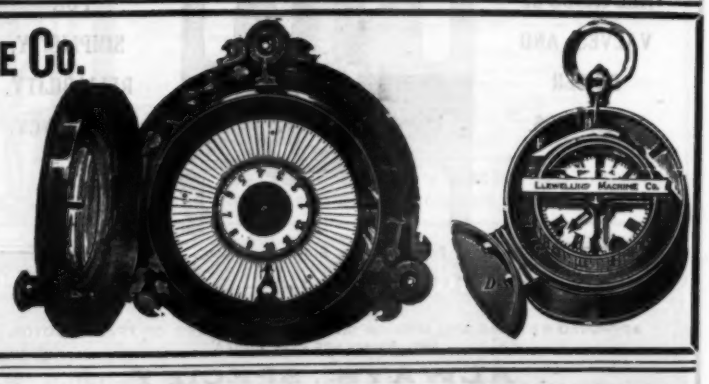
BRITISH TIME RECORDERS all types.

WATCHMAN'S WATCHES.

Send for Lists.

See our different insertions each week.

RESPONSIBLE AGENTS REQUIRED WHERE NOT REPRESENTED.



THE PATENT LIGHTNING CRUSHER & PULVERIZER

Unequalled for reducing Hard Materials such as Shingle, Gravel, Flint, Silica, Magnesite, Barytes, also Limestone, Chalk, Freestone for Building Sand, etc. etc.

THE PATENT LIGHTNING CRUSHER CO., Ltd., 14a, Rosebery Avenue, London E.C. Telephone: 4656 City

"Camel Hair" Belting

(REGISTERED TRADE MARK)

83½ TIMES ROUND THE WORLD.

The equivalent to this remarkable distance has been travelled by a "Camel" Brand Main Driving Belt during its 19 Years Service. It is still running and in good condition.

SOLE MAKERS

Reddaway

PENDLETON, MANCHESTER.
LONDON, 50-51, LIME STREET, E.C.

"CAMEL HAIR" BELTING

ALL WIDTHS UP TO 80 INCHES

Write for Booklet No. 45
It contains many useful hints on Belt Driving

Main Driving

PARSONS' TURBO BLOWERS & COMPRESSORS.

High-pressure reaction Parsons Steam Turbine direct-coupled to two-cylinder Air Compressor. Normal air pressure 80 lbs. per square inch above atmosphere. Normal output 10,000 cub. ft. of free air per minute. Maximum output 12,000 cub. ft.

Supplied to the Barrow Hæmatite Steel Co., Ltd., for their Barrow Colliery.

C. A. PARSONS & Co. Ltd.

Heaton Works
NEWCASTLE-ON-TYNE
London Office: 56, Victoria St., S.W.1.

Mais le chez d'outils

Hydraulique est Ricè Leeds

cette adresse suffiçè

Tele { grams "Press Leeds" phone 26305.

codes { ABC5 Marconi

BROUGHTON COPPER CO. LD.

COPPER SMELTERS. COPPER & BRASS MANUFACTURERS

FLUID-COMPRESSED HYDRAULIC-FORGED

COPPER BRASS & BRONZE TUBES & CYLINDERS.

COPPER INGOTS BARS SHEETS &C ELECTRO COPPERING.

WORKS MANCHESTER & DITTON. NEAR WIDNES.

OFFICES MANCHESTER BRASSEY CHAMBERS LONDON & GLASGOW

MANCHESTER.

THE MOTHERWELL BRIDGE CO Ltd.

BRIDGES, ROOFS, PIERS, TANKS, DOCK GATES

Structural Work, Hydraulic Pressed Flooring.

Telegrams: Bridge. MOTHERWELL, N.B. Nat. Tel. No. 40.

London Office: 82, Victoria St., Westminster, S.W.

See illustrated advt. last and next week.

ORR & WATT & CO LTD STEEL STRUCTURAL ENGINEERS LANARKSHIRE BRIDGE WORKS MOTHERWELL SCOTLAND

ROOF & BRIDGE BUILDERS

HYDRAULIC PRESSED STEEL TROUGH FLOORING FOR ROAD & RAILWAY BRIDGES, BUILDINGS, etc.

KENYON'S SPECIALLY COMPOUNDED "KISOL"

A cheap, durable and efficient insulator against heat radiation.

Ask for "HINTS" on the covering of Steam Pipes, Boilers, &c

SHEET METAL WORK.

WILLIAM KENYON & SONS, Ltd.

404 (Ashton). DUKINFIELD, near Manchester.

J. W. JACKMAN & CO., LTD.,

Vulcan Works, MANCHESTER.

FOUNDRY PLANT

SPECIALISTS.

WARNING.

As our Reg. Trade Mark, "STAUFFER'S LUBRICANT," is fraudulently made use of to palm off substitutes, WE HEREBY WARN USERS, and the Trade, that the use of the word "STAUFFER" in connection with Lubricant, or Grease, not of our make, is an Infringement of our Reg. Trade Mark, under which, for 40 years, the world-wide reputation of

"STAUFFER'S LUBRICANT"

(Reg. Trade Mark)

AS THE STANDARD MACHINE GREASE HAS BEEN ESTABLISHED.

Sole Makers: TRIER BROS., LTD.,

Office: 36, Victoria Street, WESTMINSTER, S.W. 1.

Works: Camberwell, LONDON, S.E. 5.

HYDRAULIC MACHINE TOOLS AND OIL MILL MACHINERY

OF ALL DESCRIPTIONS.

MUSGRAVE BROS., CROWN POINT FOUNDRY, LEEDS.

DROP VALVE & UNIFLOW ENGINES up to 4000 H.P.

CARELS

DIESEL AND STEAM ENGINES.

CARLTON HOUSE, REGENT STREET, WATERLOO PLACE, LONDON, S.W. 1.

DIESEL ENGINES up to 2000 B.H.P.

Telephone: Regent 3484. Telegrams: "Dieselben, Piccy, London.

STEEL CASTINGS UP TO 6 TONS EACH.

To any reasonable specification.

ALSO MALLEABLE IRON CASTINGS.

THE PARKER FOUNDRY CO. LD., DERBY.

MANCHESTER FURNACES LTD

ASHTON NEW ROAD MANCHESTER.

Manufacturers of Coal, Gas or Oil Fired Furnaces for Plate & Angle Heating, Forge, Metal Melting, Annealing & Case Hardening, Reheating, &c.